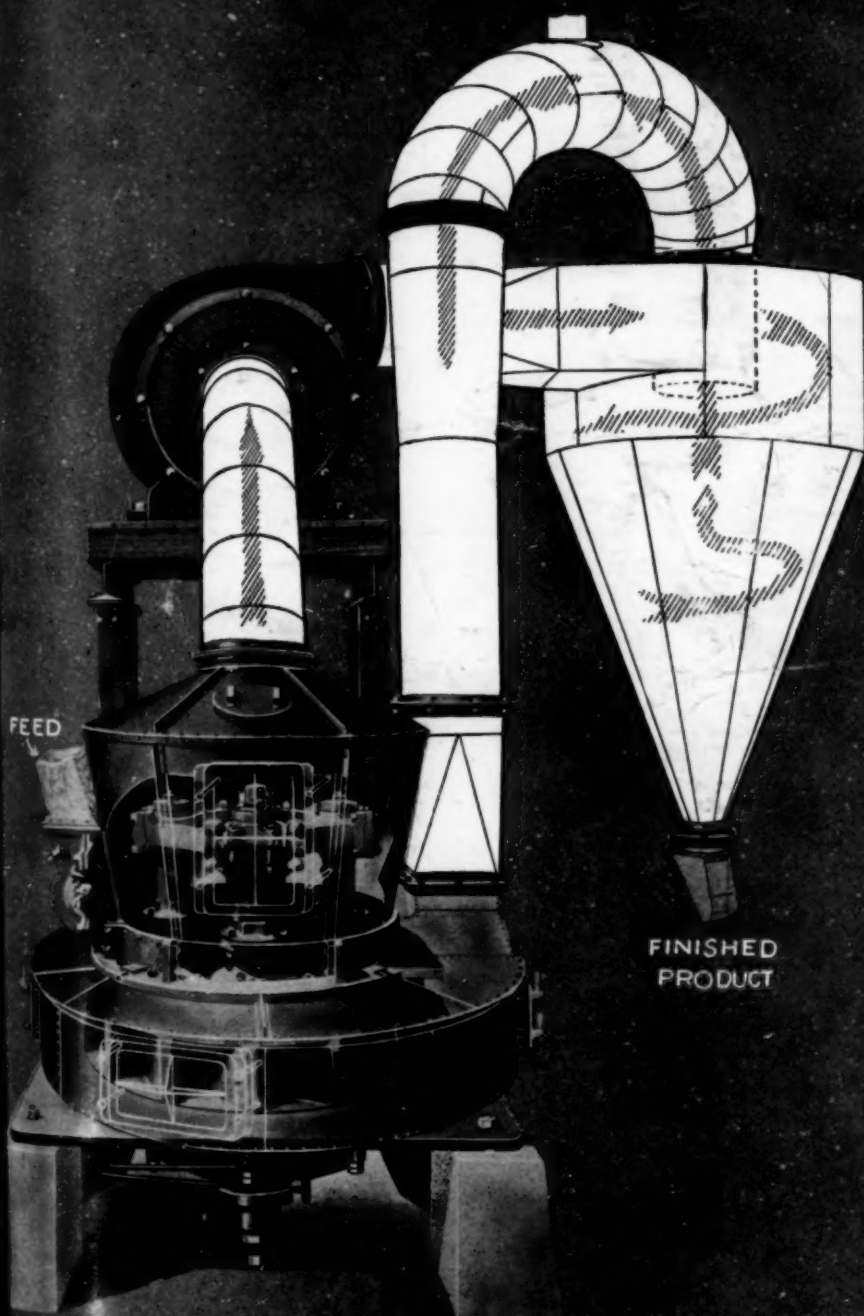


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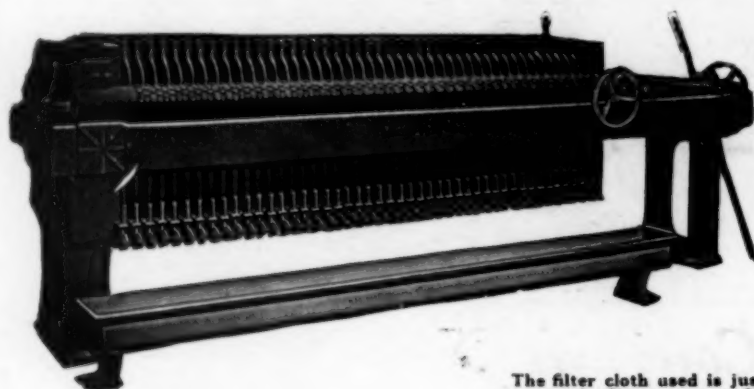
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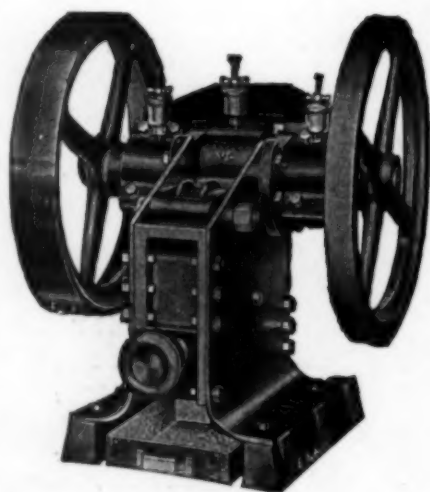
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Number 15

A Forward Movement in Chemical Engineering Education

THE announcement printed in our news pages of this week that the American Institute of Chemical Engineers has appointed its committee on chemical engineering education records a step that is worthy of more than passing attention.

The tremendous success and widespread interest in the conference which was held last spring under the auspices of the Institute showed that the field was ripe for active endeavor. The able and comprehensive report which was the basis of discussion at this conference, presented by the chairman of the retiring committee, Dr. A. D. LITTLE, of Boston, contained a complete survey of the field and indicated the points on which there must be marked activity in the future. The next step was the indorsement of the report by the Institute at its Niagara Falls meeting in June and the authorization for a committee of the Institute to carry on this work and, within three years, announce a classification of the chemical engineering courses of the country, approving those deserving commendation.

The committee has now been appointed, five members being from industry and five from educational institutions. The personnel is distinguished not only by service to industry and to education but by a soundness of ideas on this important subject and a rationally progressive attitude which augurs well for the success of the work.

"It Pays To Advertise"

ADVERTISING MEN can argue quite convincingly that anything can be sold if it is properly advertised. And there is one phase of this doctrine that should appeal particularly to technical men. It is the presentation of technical facts through the advertising pages of the daily and popular press.

It is getting to be quite the proper thing to appeal to the reader through advertising on the ground that the quality of the product advertised is maintained by very careful laboratory and plant supervision. Not infrequently the name is given of the laboratory investigator making marked achievement, and the advertiser almost invariably makes haste to stress his superiority of product when he establishes a new control method or when his research department has developed new information of interest to the user of the product.

This tendency to utilize technical achievement as a basis for publicity work should be taken into account by directors of research and chief chemists. When new work of importance is developed, the possibility of gaining advantage for their companies through judicious publicity should be recognized. Very often the

laboratory investigator or the chemical engineer will be the first to recognize these possibilities and it then becomes his responsibility to bring them to the attention of the proper officials. A technical story clearly and simply but convincingly told in an advertisement in the daily press should be helpful to all concerned.

Preaching And Practice

TWO eminent army officers, Generals PERSHING and HARBORD, speaking at the first convention of the Reserve Officers' Association, have stressed the same point—that it is false economy excessively to curtail military preparation in peace time. General PERSHING in stressing this point uses the following language: "It would be false economy to save a few dollars by neglecting common-sense preparation in peace time and then to spend billions to make up the deficiency when war comes." General HARBORD lays greater emphasis upon the intimate association between those responsible for the management of military affairs and those whom he characterizes as "stockholders" in the business. The doctrine advanced by these officers is sound and would meet with almost universal agreement, but it is unfortunate that the practice of the army, particularly the theory upon which General PERSHING has administered army affairs, does not accord with the doctrine which he advocates.

If there is any branch of military activity in which preparation in time of peace and training of an organization nucleus is required, it is in the field of chemical warfare. In this particular field it has seemed to be a hobby of the Chief of Staff to discourage any progressive thinking or constructive effort. He, more than any other individual in the world, is responsible for the rather abortive effort made in the treaty preventing the promiscuous use of poison gas. In that field the conclusion which he has advocated has been illogical.

It is idle now to argue whether the treaty should have been adopted in the form and phrasing which was approved. But it is still entirely reasonable to insist that the preparation and training of men in the modern methods of warfare through use of chemical weapons must go forward if any degree of security is to be had. Troops put in the field must know how to defend themselves against gas attack, for if there be any conflict of consequence it is certain that some forms of chemical warfare will very promptly be used. Moreover, there should be the nucleus of an offensive chemical warfare service thoroughly trained to handle all the problems involved in preparation, transportation and projection of war chemicals. Especially is it essential that work on tear gases, sneeze gases and the other non-toxic weapons be thoroughly developed.

While the Chief of Staff and the Deputy Chief of

Staff are pleading with reserve officers on behalf of Dorby. Then Mr. Capital wrote underneath: "In case preparedness, it would be well if they think through the problems of chemical warfare again. If they will carefully consider all aspects of the case, they cannot fail to realize that this branch of the service has been sadly handicapped during the last year or two. In fact, were it not for the much broader, better vision of the Naval Staff our Chemical Warfare Service would be practically out of business at present."

During the coming sessions of Congress it will be appropriate that General PERSHING and his principal deputies lend a much-belated support to adequate appropriations for this work. An extra million dollars a year in this field will maintain effective research and development; and if ever again we suffer from serious war, this small expenditure will represent insurance having face value in the billions. May we not hope that the practice of high army officers will agree in the future more closely with the preaching than it seems to have done in the past?

Anecdotes of Old Galchester

WHEN chemists get into high finance, the bell should ring. There were Derby and Darby and Durby and Dorby of Galchester who made, let us say, dubium oxide, dubium chloride and a series of widely used dubium compounds. Each one was in business for himself, each was rich, possibly a little vain, as becomes the habit of rich men, but they were a pretty good sort, every one of them; and every one proud of his reputation as a citizen and a manufacturer. Their friendship was an asset, especially to their customers; for when bad times came around they did their best to see their old customers through, while if markets got crazy and prices went up in the air, they stuck to their contracts, fulfilling them exactly as agreed. They would even renew them in seasons of great prosperity at the lowest figures they could profitably make. Each one was jealous of his good will, and resolved to maintain it at any cost. They were also good friends.

Off in one corner of the county was Digby who had dubium interests, and Derby thought it would be a good thing to buy him out. He therefore proposed joint action to his friends Darby, Durby and Dorby, who agreed, and negotiations were begun. They bid 5, and Digby asked 10, but finally they compromised on 9. Digby proved to have more dubium interests than they had reckoned on, so in order to swing the deal they called on Mr. Quickturn Capital, who asked them questions about their own business. He was interested, having already picked up "a few blocks of stock" in the dubium industry.

Mr. Capital was amazed. He was also shocked. But he said he would come into the deal and help them out. He offered to put up \$5 in cash and to give his note for \$2.50 more for each of Digby's dubium units and to let the other gentlemen put up \$1.50 more, to make up the price; but this was with the proviso that they give him one-quarter of the profits on the transaction. To this they agreed. Digby said if they were to give notes he wanted \$9.50, and Mr. Capital surprised his associates by his quick decision. He was above bargaining.

"Let it be \$9.50," said he, "and we will make one note for the whole amount. You gentlemen can indorse it, and I'll put my name on last and guarantee you."

To this all agreed, and a note for the large sum was made to Digby and indorsed by Derby, Darby, Durby and

any or all of the above indorsers should default on this note, I agree to make good such default. Quickturn Capital." Digby turned over his papers; Capital handed him the note.

"I've always remarked," said Mr. Capital, "that you chemists are children in business. You're soft. You neglect your opportunities. Business is business; it isn't a tea-party. You have foolish ideas about good will, and you sell dubium at a price way below the market to your so-called customers—and let them reap the profits. Business is business, I repeat, and its purpose is to make profits. You people don't know how to keep books, and you don't know anything about markets or how to control them. In fact, you're little children. This incident of the note is an example of how slow you are at trading. You're way behind the times. This whole trade is a mere bagatelle. We'll sell this Digby dubium at 25, but that is nothing to what we can make. I think I shall have to take a hand in your affairs and look into the dubium market."

He proceeded to do so while the others lost their breath once more and caught it again. Then followed weeping and wailing and gnashing of teeth, but there rolled in such a flood of golden money that, according to the legend, Derby and Darby and Durby were comforted. But Dorby retired because the cries smote his ears and caused him great distress. Dorby comforted himself with apples.

Long Range Price Trends

WE HAVE all been very much interested, since the armistice, in commodity prices. The interest has not been merely the selfish one involving the question of what we could get for such dollars as we ourselves had. Prices have furnished an index to economic conditions, in which we all have a general interest.

When, just after the armistice, prices displayed a greater reluctance to decline than had commonly been expected, we wondered whether this meant that the value of the dollar had been permanently depreciated. Some observers insisted that such was the case, citing the large increases in the currencies of various countries together with the large issues of government bonds. If so, the real value of all bonds and mortgages had been greatly depreciated, while at the same time it would be justifiable to mark up the value of all real estate, plants, etc.

In the great price rise of the latter part of 1919 and the early part of 1920 the common view was that the particularly high prices represented a deficiency in production, the assigned reason being that men were not working hard enough. With the declines of 1921 we concluded that men were working harder and manufacturers and dealers were contenting themselves, perforce, with smaller profits. More recently prices have been advancing again, and most people are talking about "secondary inflation."

We have got into the way of making practically all price comparisons by using the 1913 average as standard. Undoubtedly it was necessary to adopt a standard, and the calendar year before the war seemed the natural year to take. The point that it is desired here to emphasize is that we are certain to make serious mistakes if we consider 1913 a perfect standard, with which all current prices may properly be compared. The easy concept must be avoided that 1913 was really

typical, while furthermore we must not overlook the fact that in nine years many conditions would have changed had there been no war and no inflation. All commodities would not now be at the same level as in 1913, or 25 per cent above or 25 per cent below. Some would be higher, some would be lower, and even the general average would not be the same.

The Department of Labor has just issued "Wholesale Prices, 1890 to 1920," this being the eighteenth of a series, begun in 1902. The last bulletin of similar character was published in 1916. Meanwhile there has been a change in the system whereby the relative to 1913 is given for each of many commodities or groups, for each year beginning with 1890. Thus a fresh and valuable means of comparison is now afforded.

In order to judge rightly the significance of a given comparison, that the commodity is 125 or 150 or 175, relative to 1913, we need to consider how the commodity in 1913 compared with prices in previous years. The commodity may have been falling up to 1913 and in that case it is particularly remarkable if now it is much above 1913. It may have been advancing up to 1913, in which case a further advance is not remarkable. At this late date we cannot hold that because one commodity is 150 relative to 1913 another commodity should likewise show a relative of 150.

To illustrate, one finds that, with 1913 prices as 100, carpets were at their highest in that year, having been 80 in 1890, 70 in 1895 and 1896 and 92 to 93 in 1909, 1910 and 1911. Wheat, on the other hand, was 101 in 1891, 63 in 1893 and 126 in 1909. Thus it would be much more remarkable for wheat than carpet to have a high relative to 1913 at the present time. Again, compare brick and plate glass. Brick was 100 in 1890, 75 in 1897 and 130 in 1906. Its 1913 price was therefore quite typical of the average for a period of years. Plate glass, on the other hand, was 180 in 1890, 139 in 1900 and of course 100 in 1913. Thus it had been experiencing a great decline. In no year from 1890 on were matches as cheap as in 1913, while in none of those years were kitchen tables as dear.

Views on

University Research

IT IS a matter of common remark that "experts disagree." Men of approximately the same education and environment often develop wide differences in view on questions of common interest. But it is worthy of notice when leading educators start from the same premise, defining the proper aim of education, and finish with entirely different proposals as to how that destiny can be met. Particularly is this true when both of them were formerly associated as deans in the same university.

They both recognize that the university must be something more than a storehouse, where the sum of human knowledge is iced away and preserved. Furthermore, the university must be of use to a far wider public than the favored students who are fortunate enough to attend its classes. And they are further in agreement that the university faculty should be investigators as well as instructors. In short, they recognize that a modern university has grown beyond the ambitions of its predecessors. Indeed, the end of the dark ages and the revival of learning were both foreshadowed by the determination of educated men to push out into the unknown and discover more facts to add to the accumulated store.

But that's about as far as these two scholars agree. A modern university, says one, should have as its "chief objective the development of knowledge, while instruction becomes incidental." By no means, says the other, "Scientific research and the advancement of knowledge should be in a position of equal importance with the work of instruction." An even wider difference of opinion exists on the methods of research. The former says, "The faculty becomes a body of real scholars who will exert all their powers toward discovering new facts and setting them into their proper places with related facts in order that principles may be brought to light—a great process of critical analysis and synthesis, with logical deduction which we call research." But the second educator holds that "the solution of the problems of most industries can best and most economically be undertaken through association with the universities and technical schools," and further in his address argues the thesis that the faculty should devote their time not pre-empted by the class room to the solution of troubles cropping up here and there in the industries.

We venture to disagree with both these conclusions.

From an engineer's point of view it is essential that the universities keep *instruction* as their great work—instruction of matriculated students and instruction of the far greater public outside the cloistered walls. An institution which does not pay first attention to instruction of others besides its own faculty is not a university. Consequently we shall not argue the point at length. On the other hand, an institution officered by immature instructors is not a university, as we understand the term.

There are two very good reasons why the faculty of a technical school should engage in research. In the first place, a true teacher is also a student—he is curious about the unknown. There is that within his spirit which urges him to investigate. In the second place, the schools and their faculties must advance in order to hold their jobs. Abstruse science of yesterday is commonplace technology of today. So if there were not more new things constantly discovered, the engineering and scientific colleges would quickly become trade schools.

It seems agreed that investigation is necessary to the well-being of our schools. But what kind?

We believe that the true scientific researcher does not go to the XYZ bolt works and select his problem from its scrap pile, nor to the farmers of Jones' Corner and bring back a sample of bad vinegar. But with a background made up of thorough familiarity with the literature of his specialty, an acquaintance with the principal workers in the field and the useful applications which have so far been made, he selects one of the broader problems that remain to be solved and attacks the matter with a quite disinterested perspective. He throws all the resources he can bring to bear into the search, and in time, perhaps years, reaches a solution—or at any rate it becomes known that he is very well informed in that particular branch. Then with the advantage of this position, he is able to give the public the maximum amount of seasoned, correct advice with the least amount of distraction from his ordered routine. And that's the only kind of advice he will attempt to give. It is more than doubtful that this eminent and influential position could ever be reached by a university faculty that devoted itself to commercial research—which is time consuming, but rarely broad and never disinterested.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, Sept. 18, 1922.

CHEMICAL markets are, on the whole, featureless, prices remaining steady, although the outlook and industrial conditions continue to show improvement. Pitch and carboic acid crystals are firmer, American demands being a favorable factor in the latter case. The trade in aniline dyestuffs and intermediates is improving. There is increased demand for sulphuric acid, about two-thirds of the available plants being in continuous operation. The recent reduction in railway freight rates is having a beneficial effect in enabling manufacturers to enlarge their areas of distribution, particularly of products for which transportation charges are a material factor.

REPARATION DYES TO BE DISTRIBUTED BY BRITISH DYESTUFFS CORPORATION

Perhaps the principal factor underlying this change in the Board of Trade's policy was the fear that the Central Importing Agency might ultimately compete with old-established traders. No attention is being paid to the critics who have made criticism their business at all costs without being in a position to propound any reasonable alternative. The corporation is to act substantially as agent of the government on a commission basis and the business is to be handled by a separate department not concerned with the disposal of the corporation's products. Prices are to be fixed by the government with an advisory committee on which the Color Users' Association is to have two representatives. The general impression is that the new arrangement will work very satisfactorily from the user's standpoint and the prospect of its benefiting producers is already reflected by an appreciation in the quotation for the corporation's shares. Sir William Alexander, the chairman, has emphatically contradicted the rumor that the color users are dissatisfied and his forthcoming visit to the United States should lead to a useful interchange and clarification of ideas on this very controversial industry.

INDUSTRIAL AND GENERAL DEVELOPMENTS

The British Cellulose Co.'s scheme for providing new capital is approaching fruition and prominent directors of the Société de Soie Artificielle de Tubize (Belgium) have joined the board of the company and of the "holding company" which is providing the new capital. Acetyl cellulose silk is now finding its way into the market and although, as is usual with a new product, its value is likely to be exaggerated, the fiber is being favorably considered as being a closer approach to natural silk in spite of difficulties in dyeing which are still in process of being surmounted. The prospectus of the "holding company" will be issued shortly and the £300,000 which is to be provided as first mortgage debenture stock is repayable in 1924 or by purchase in the market. There has been a very interesting exchange of letters between Sir Harry MacGowan, the managing director, and the Belgian silk works, from which it may be gathered that sales are increasing sufficiently rapidly to warrant an increase in the capacity of the plant from 1 to 3 tons per day and also for the installation at Tubize of a half-ton plant for manufacture of the new silk. This decision has been taken earlier than was originally provided for and indicates confidence on the part of the Belgian directors.

Owners of motor lorries and omnibuses are displaying interest in the use of "Discol" motor spirit, which is being marketed by the Distillers' Co., Ltd., and is mainly a mixture of alcohol (made from molasses) with benzol and other hydrocarbons. Considerable economies in fuel consumption have been recorded in this connection by the use of an economizer tank holding three-quarters of an imperial gallon, which when filled with "Discol" fuel is stated to be of sufficient capacity for 150 miles run. The hot water from the radiator is circulated through a coil in this tank and by means of an adjustable air inlet a steady supply of gas of up to 30 per cent of the normal fuel requirements can be fed to the carburetor, variations in running being then taken up with petrol from the carburetor itself. The cost of the fuel is stated to be 1s. per gallon and increases of mileage of 75 per cent per gallon have been recorded, while the makers guarantee no pinking in the engine even at full load with ignition fully advanced.

SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL ISSUES SEVENTH REPORT

Although much really useful work has been done in an unobtrusive way, a great deal of the work reported in this publication has not yet produced tangible results. As a contemporary aptly puts it, Faraday's simile "What is the use of a baby?" is still the best answer to scoffers at scientific research. Perhaps the most immediate benefit achieved lies in reduced consumption of fuel, increased output in gas works and the indirect fuel saving to shipowners from the steady work accomplished in the National Froude Tank. A saving of about 5 per cent was shown in many cement works with an increase of 10 per cent in output. Among the various state-aided research associations, those for the cotton and linen industry have done particularly useful work, while the food investigation board is able to record a success in the diagnosis of "brown-heart," a disease which affected apple shipments. Previously attributed to insects, it was found that the apples had been affected by self-evolved carbonic acid gas. Perhaps the most useful innovation is the establishment of co-ordinating research boards and committees to prevent overlapping and to facilitate investigations that are of common interest to several industries.

SUCCESS OF BRITISH ASSOCIATION MEETING

The meetings of the Chemical Section have this year had an exceptionally good lay press and as a result there has again been some criticism of the policy so frequently insisted upon by other learned societies of restricting publication prior to the appearance of contributions in the societies' own journals. None of the bodies criticised seems to possess sufficient courage to give the idea a trial and the critics are too apt to forget that the British Association is really an exception, inasmuch as it meets only once a year and possesses insufficient funds to publish the whole of the papers contributed to it. The symposiums on hydrogenation of oils and particularly that of the nitrogen industry were well attended. Dr. Harker's review of the nitrogen situation was really a masterly exposition, although the speaker's lips were unfortunately sealed in respect of some recent important developments. The published reports of the various papers presented are instructive reading from the national standpoint and tend to show that the German menace is still an important factor.

Detroit Meeting American Society for Steel Treating

EDITORIAL STAFF REPORT

STEEL TREATERS have done something which is perhaps unparalleled in the history of American technical societies—they have held a national convention at which 40 per cent of their entire membership enrolled as present. Being held in Detroit, several of the larger local chapters in the Middle West came in a body, but in order to set that record a great many others traveled from New England and the coast states.

They were rewarded by the best meeting and exposition the American Society for Steel Treating has ever had. Being but a young organization, the earlier conventions showed many marks of inexperience on the part of their managers. Much praise is therefore due to the Detroit committees, under the general chairmanship of W. P. Woodside, for their part of the work. They provided quite adequate meeting and exhibition facilities in the magnificent General Motors Office Building, gathered together a notable list of meritorious technical papers, and provided a number of excursions into manufacturing plants and social entertainments which filled every minute. No doubt some of the successful results—particularly in the exposition of steel and steel-treating equipment—were due to the co-operation of the American Drop Forging Institute, which held its annual convention in conjunction with the Steel Treating as a sort of co-operative affair.

BIRTHPLACE OF BESSEMER STEEL IN U. S.

One feature of the non-technical activities is worthy of comment and emulation. It seems that the first bessemer steel made in America on a commercial scale was blown in 1864 by William Kelly at the village of Wyandotte, on the river a few miles south of Detroit. The site of these works—now long since dismantled—is the business center of the present community, but is now marked by a bronze tablet erected by the Detroit members of the Society for Steel Treating.

Kelly, it may be recalled, was an ironmaster who had discovered the pneumatic process many years before when observing the action of the air blast on the metal in one of his forges, left unprotected by the usual charcoal blanket. In fact, he had made knobbed iron with little or no charcoal for many years before he was able to interest anyone sufficiently to finance large experiments on what is now known as the bessemer process. A plant was finally erected alongside the blast furnaces of the Wyandotte Iron Works, and operated with the usual vicissitudes of radically new processes for several months. A considerable tonnage of steel, however, was made, rolled and sold. During part of that time Captain Robert W. Hunt was in charge of the operations, and fortunately this venerable engineer was able to be present at the dedication ceremonies and give some reminiscences of those early times.

An echo of the vicious litigation which was fought over the Kelly American patents, the bessemer British patent and the improvements made by Mushet was heard in the remarks made by William C. Kelly, the son of the discoverer of the pneumatic process. It

seems that Kelly's achievements in the manufacture of iron without charcoal had become fairly well known, both here and abroad, through information spread by Kelly's Cincinnati house—jobbers and importers of iron and steel. During these times the forges were visited by two Englishmen of intelligence, who remained a few months, even assisting the owner in his experiments looking toward an improvement of the process or an adaptation to larger-scale operation, eventually leaving as suddenly as they appeared. According to the son, William C. Kelly, one of these visitors was identified by his father as Bessemer, when a photograph of the latter was brought over from England shortly after the introduction abroad of Bessemer's process in a commercial way. This incident, mentioned by William C. Kelly as never before having been made public, was told him by his mother before her death, several years ago.

Session on Carbonizing

CYANIDE HARDENING

Some experiments on case-hardening were reported by A. H. d'Arcambal, metallurgist for the Pratt & Whitney Co. He treated 1-in. rounds of S.A.E. 1015 steel in a bath composed of 76 per cent sodium cyanide, then removed the shell by 0.005-in. steps, analyzing each sample for carbon and nitrogen. A typical set of results are given below, after a heating for 45 minutes at 1,550 deg. F. and cooling in lime:

Sample	Carbon	Nitride Nitrogen
First 0.010 in.	0.44	0.353
Second 0.010 in.	0.22	0.036
Third 0.010 in.	0.18	0.017
Fourth 0.010 in.	0.14	0.009
$\frac{1}{2}$ center drillings	0.14	0.006
Original stock	0.14	0.003

Carbon and nitrogen are both increased by temperature and time—e.g., 120 minutes at 1,550 deg. F. gives C 0.56 and N 0.451 in the outer 0.010-in. shell. Forty-five minutes at 1,450 deg. F. gives an outer case of only 0.30 C and 0.215 N. When hardened and fractured, the hard "case" measures about 0.010 in. deep for all heatings. Under the microscope, nitride needles are observed near the "breaking-off" point of the case.

IMPACT TESTS ON CARBONIZED SAMPLES

d'Arcambal also presented many data on the impact strength of several commercial steels after carbonizing 4 hours at 1,650 deg. F. in a mixture of $\frac{1}{2}$ sole leather, $\frac{1}{2}$ BaCO₃, and $\frac{1}{2}$ hardwood charcoal. Subsequent heat-treatments were on the "high side" of S.A.E. recommendations, all samples being drawn to 350 deg. F. Some of the results are given in Table I (averages of 3 to 6 samples). Depth of case was measured under the microscope, and found to be 0.025 in. for the carbon steels and 0.03 in. for the alloy steels.

All pieces packed in sand and given the regular heat-treatment showed very much higher impact values than corresponding samples packed in the carbonizing mixture, a result to be expected. Heating for this long period in a neutral atmosphere will permit all soluble impurities to diffuse thoroughly; subsequent double

Forty Per Cent of the Membership Present at the Best Convention the Society Has Ever Held—Papers on Carbonizing, Heat- ing Practices, Tool Steel, Hard- ness and Metallurgical Education

TABLE I—PHYSICAL TESTS ON CARBONIZED SPECIMENS

Steel	Carbonizing	1st Quench	2nd Quench	Izod	Sclero-scope Case	Brinell Core	Izod Fractures		Tensile Tests		
							Case	Core	Ultimate	Elongation in 2 in.	Reduction
S.A.E. 1015*	Carbonized; pot-cooled	1650-oil	1440-water	2	90	157	Slightly coarse	Coarse	.....	.....	.....
do	do	1450-water	None	2	88	180	do	Very coarse	.....	.....	.....
do	Carbonized, oil-quenched	1650-oil	1440-water	2	90	157	.....	.....	.....	.....	.....
do	do	1450-water	None	3	..	166	.....	.....	.....	.....	.....
do	Sand packed, pot-cooled	1650-oil	1440-water	70	..	163	.....	Fine	103,100	11.5	26.5
do	do	1450-water	None	10	..	180	.....	Very coarse	127,500	4.8	5.3
S.A.E. 6120†	Carbonized; pot-cooled	1650-oil	1475-water	10	92	265	Fine velvety	Fine	.....	.....	.....
do	do	1500-water	None	2	92	255	Fine	Coarse	.....	.....	.....
do	Sand packed; pot-cooled	1650-oil	1475-water	37	..	265	.....	Fine	125,500	17.0	35.4
do	do	1500-water	.....	23	..	252	.....	Coarse	137,800	13.1	30.0

* Analysis: C 0.19, Mn 0.42, P 0.01, S 0.04, Si 0.1.

† Analysis: C 0.14, Mn 0.65, P 0.008, S 0.03, Si 0.13, Cr 1.03, V 0.18.

quenching will produce very fine grain. Izod bars so treated should show maximum toughness. Carbonizing, however, places a mass of very brittle martensite at the root of the notch, where the force of the impact is concentrated. Splitting of the specimen starts with a minimum of resistance, and results in correspondingly low values for the work of rupture. The double heat-treatments recommended by the S.A.E. give fine-grained fracture in case and core for all carbonizing steels, and the single quench refines the case, but leaves the core very coarse. The grain of an impure steel, such as bessemer screw stock, is not refined, however. All cases which had scleroscope over 90 were hard to a Nicholson flat temper-testing file; 3½ per cent Ni steels (S.A.E. 2315) gave scleroscope 87, and file-soft cases. After double quenching, all cases show a fairly fine martensitic structure, containing some globular cementite. The single quenching given preserves a trace of cementite network. Steel 6120 develops no network at any time. In general, this network is suppressed by quenching from the pot.

Izod values, in the single quenched condition, ranged the steels tested thus: 6120, 2315, 1015, 3115 and 1112. Oil-hardening gear steels range similarly—e.g., 6150, 2350, 3250 and 3150.

In view of the brittle material existing at the root of a notch, after the test-piece has been carbonized and hardened, it is doubtful if the impact specimens give results of much importance. Major Bellis noted that carbonized rifle receivers would withstand 150,000 lb. pressure under actual ballistic test, whereas the same part before carbonizing would fail at 85,000 lb. Notched test specimens, however, would invert the order.

PRECAUTIONS IN CARBONIZING

H. B. Knowlton, of the Milwaukee Vocational School, recounted precautions which it is necessary to observe in commercial operations in order to insure uniform results.

First, it is necessary to have uniform carbonizing material. If this is homemade, or if a certain amount is being re-used, it is necessary that it be quite thoroughly mixed. Next, the temperatures must be under control. Time at heat is the most important thing to regulate, and in view of the variations in furnace firing, temperature of walls, loading of boxes, and so on, it is essential that the actual temperature at the center of the boxes be observed, either by a properly placed pyrometer or by frequent withdrawal of test pins. Given these factors under control, the most fruitful source of trouble is leaky pots. Air or furnace gases entering them will burn the carbonizer, and the pieces near the leak or the top of the charge will actually be oxidized. Erratic results are also found on parts placed too near the surface of the pot, if the carbonizer shrinks and settles unduly.

Session on Tool Steel

BREAKDOWN TESTS

About twenty-five brands of commercial tool steel have been investigated by the breakdown test by H. J. French of the Bureau of Standards and Jerome Strauss of the Naval Gun Factory. Lathe tools (1½ in.) of approved shape were given recommended or appropriate heat-treatments, and then tested dry to break down on a heavy duty motor-driven engine lathe, cutting a 15-in. forging of heat-treated 31 per cent Ni steel (Brinell 200). A feed of 0.045 in. and cut ¼ deep, was used. Under fast cutting, failure ordinarily occurred in less than 15 minutes. The amount of energy required to drive the lathe was not affected by the kind of steel in the tool.

Selection of the steels was made at random from about sixty-six lots of tool steel on hand. These had been analyzed and grouped into the following classes (analyses noted here being the average):

	C	Cr	W	V	Co
Low-tungsten, high-vanadium	0.65	3.7	13.0	1.5	
Medium-tungsten	0.66	4.0	15.0	1.5	
High-tungsten, low-vanadium	0.66	3.5	18.0	0.9	
Cobalt	0.69	3.7	16.4	1.2	3.3
Special (with molybdenum or uranium)					

Three tests were run, at various speeds, and the performance, noted as per cent of time of cutting of the best type, follows:

	Speed 67	Speed 61	Speed 60	Total
Low-tungsten steel	100	94	100	294
Cobalt steels	68	100	97	265
High-tungsten steels	56	56	64	175
Medium-tungsten steels	54	56	62	172

There seems to the authors to be such a great variation in the results, both for individual tools in the same test and for the class averages in tests which have their only difference in a minor change in cutting speed, that breakdown tests should not be relied upon to govern large purchases of tool steel in a competitive market, except when the tools are for very heavy roughing work, as in the test itself. There seems to be no doubt, however, the low-tungsten steels or cobalt steels are definitely better for this duty than the high-tungsten varieties.

Uniformity of the tests became better as the severity was reduced, and was very good when failure occurred at about 20 minutes, the time recommended years ago by Frederick W. Taylor. Mr. Spaulding recommended Taylor's method rather than the severe breakdown tests, because he had found that the former gave results which could be duplicated consistently to within 5 per cent, regardless of the kind of cutter or tool tested. J. H. Parker, on the other hand, told of an extended breakdown test which selected steel X as being best and Y as second choice. Twelve sizes of each steel were then purchased, six tools were made by each size and put into regular production, working on appropriate

machines and various alloys. Ten grinds were given each tool. In every shop test, X (a low-tungsten, low-vanadium steel) was first, and Y (a high-tungsten, low-vanadium steel) was second.

PROPER MICROSTRUCTURE FOR BEST MACHINING

J. V. Emmons, of the Cleveland Twist Drill Co., presented an account of that company's extended studies on the influence of the microstructure of high-carbon tool steel upon the ease and excellence of the machining operations necessary to form it into a cutting tool. Such steels as received by them, having been given an anneal at the mill, would always show more or less massive cementite (the remains of the original network) more or less sorbite or pearlite, or pearlite in various stages of decomposition to ferrite plus spheroidized cementite. The variations cause troubles of such moment to them that they anneal all such steel received to a definite microstructure found most suitable to their shop conditions. If a variety of machining operations—such as turning, milling, fluting and tapping—have to be done on the same piece, a compromise structure is chosen. In general it will usually be one containing but few traces of the original massive cementite network, and perhaps only 25 per cent of the area covered by lamellar pearlite, the rest being spheroidized. In general, these slight changes in structure have far less influence on the final hardness and toughness of the steel, if they are given a heat-treatment in keeping with their constitution. For instance, if coalescence of the cementite is into unduly large particles, the tool must soak for a longer time at the hardening heat to get these carbides uniformly diffused in the austenite.

Several speakers emphasized that Mr. Emmons' paper was one which should be used as an indication of the correct principles of operation rather than a detailed guide. There seems to be a very powerful "shop factor" operating in such problems. For instance, several manufacturers of taps have shop methods and machines which are practically identical, and purchase steel of the same chemical composition. Yet one will specify a maximum Brinell hardness of 160, and another a minimum of 200. Each believes he is getting the best material for quantity production. Similarly manufacturers of ball bearings use the same shop methods and the same kinds of steels. Yet Plant A prefers 160 Brinell, B specifies 160 to 180, and Plant C demands 180 to 200.

HOLLOW DRILL STEEL

A brief account of the terrific duty which is imposed on hollow steel for rock drills was described by N. B. Hofman, of the Colonial Tool Steel Co. Until about 2 years ago nearly all of this steel used was a plain carbon steel. Since that time several attempts have been made to market alloy steels, but they have not been entirely satisfactory, owing to the fact that the forging and hardening of the steels is invariably done in the crudest blacksmithing manner by men who do not understand the idiosyncrasies of modern alloys. However, a steel containing 0.75 to 0.85 C, 0.25 to 0.35 Mn, 0.12 to 0.16 Si and 0.2 V has given very excellent results. It is hardened and tempered like the more usual carbon steel, and has given from two to three times the life in endurance tests and actual service. One difficulty still to be overcome is in the condition of the metal surrounding the longitudinal hole. By common methods of manufacture it is decarbonized and too often full of minute

cracks or folds from which detailed fractures—the so-called "fatigue failures"—commence and spread rapidly.

Session on Heating Practices

SCALE FORMATION UPON HEATING STEEL

G. C. McCormick, of the Crompton & Knowles Loom Works, Worcester, pointed out that the terms "neutral atmosphere" and "reducing atmosphere" as used in shop parlance are misnomers. His experiments show that it is impossible to operate a semi-muffle furnace without badly oxidizing steel left in it for an hour at temperatures greater than 1,200 deg. F.

Using a tube furnace, with an atmosphere of still air, he plotted the losses by scaling¹ after an hour's exposure at various temperatures. The curve resembled a parabola—the loss was very low at 1,200 deg. F., but increased at an accelerating rate, and at 1,600 deg. was excessive—0.50 gram per sq.in. of surface. In all the experiments, low-carbon steel scaled more readily than high-carbon, probably because the latter had to be decarbonized as well as oxidized.

Shopmen call a "neutral" atmosphere one where the fuel is fed into the combustion chamber with just sufficient air to burn it. The furnace then contains an atmosphere made up of the products of combustion: little or no oxygen but much CO₂ and H₂O, both of which, as a matter of fact, oxidize steel badly at high temperatures. It was shown that the scaling loss in a furnace operating with such a "neutral" atmosphere was about as great as in still air.

Again, the term "reducing" atmosphere refers to one where an insufficient amount of air is supplied the burner; therefore the furnace atmosphere contains more or less CO, H₂ or unburned hydrocarbons. It is characterized by a "hazy" heat and flames burning around the door and exhausts. Mr. McCormick experimented in a furnace which was operating on the maximum surplus of gas possible to give it. The atmosphere analyzed 11 per cent CO₂, 0.8 per cent CO and no oxygen. Nevertheless scaling continued at about half the rate in still air.

It is recognized, of course, that for brief stays at temperatures even much above 1,600 deg. F. oxidation may be materially reduced by operating with a large excess of fuel. Yet it appears impracticable to produce an atmosphere in a commercial semi-muffle furnace which will not scale badly after several minutes at temperatures above 1,200 deg. F. In other words, "a high-temperature furnace always scales." Consequently the ordinary terms "neutral" and "reducing"—when referring to atmospheres in such furnaces heating steel—should be abandoned.

ELECTRIC FURNACES

C. L. Ipsen presented a brief paper describing some electric furnaces which have done very good service in heat-treating. The heating elements consist of loops of bare nichrome ribbon, hung on refractory lugs built into the furnace lining. These loops may cover the side walls, roof and even be placed under the floor, which latter is usually constructed of a good conductor of heat, like special alloys or carborundum brick. Turret furnaces with rotary hearths are becoming very popular for continuous production. One such has now been in operation 8 hours daily for 3 years without any expense for renewals. Current is switched on auto-

¹Scale was removed by dipping the steel into cyanide for 10 minutes at 1,450 deg. F., quenching in water, and cleaning in soda.

matically at 4 a.m., the furnace is up to heat when work starts in the morning, and is automatically controlled during the day. Furthermore, such furnaces avoid the smoke, heat and noise of a fuel-fired furnace and may be installed in their proper place in the production stream without becoming a nuisance. Furthermore, annealing may be done in automatic electric ovens at night, requiring practically no attention and taking advantage of low rates for off-peak loads.

Discussion on Hardness

An extended discussion on hardness testing was held under the chairmanship of Major A. E. Bellis, in which a large number of members participated. Dr. H. P. Hollnagel, of the Lynn plant, General Electric Co., laid the matter open in a paper describing the various popular methods of measuring "hardness" and the inherent difficulties in standardizing and correlating them.

"Scratch hardness" is the oldest method, and perhaps the most used. A physicist performs the test by drawing a minute jeweled point across a smooth surface, and examines the width and depth of the microscopic furrow cut across the individual crystals of the piece. Ordinarily, an engineer is more interested in the properties of an aggregate of crystals, rather than of the individual crystal—he takes a set of standard files, and judges which will just scratch the piece. In this way he gets a relative value. File testing, however, would probably be most difficult to standardize—the files themselves would have to be quite uniform and never used after slightly dulled; furthermore, the speed and cutting pressure introduce a very large personal factor. As an illustration: If conditions are right, diamond will cut diamond, and chalk will polish quartz.

"Wear hardness" has been proposed as a term devoting the time required to wear 0.001 in. from a pin under a fixed load. In such a test the original surface becomes quickly polished (covered with an amorphous film) and therefore the specimen hardens as the test proceeds.

"Penetration hardness" denotes the usual method employed by metallurgists, wherein they press a ball or point into a surface and measure the indentation. To perform the test the material must be overstrained, thus automatically hardening the deformed material. In manganese steel this characteristic is so aggravated that figures for penetration hardness do not mean anything. In other metals, the method is extremely useful, despite the limitation that its results are greatly influenced by the properties of the material in its deformed state—even when the test is so superficial as barely to penetrate the surface.

Deformation under impact has been utilized in many commercial hardness testers. Some of them are of the semi-resilient type, where the indications are estimated by the rebound of the testing implement. This method is thought by Dr. Hollnagel to be especially defective, since the rebound is a function of the duration of impact, which in turn varies with the manner and speed by which stress waves travel through the body which is struck. Of all kinds of hardness, that kind which presents resistance to a rapid penetration—like projectile and armor plate—is the most difficult to control or reproduce.

Even when the ideal test is established many of the present hardness tests, and more to be devised, will always be useful for "inspection" purposes. Of course, they will give only relative figures, and in some cases will only be able to pick out defectives from parts

supposedly all the same. Their use will always involve a large personal factor and considerable common sense—nevertheless, they are performing a very useful rôle in technical control of shop practices.

It would be desirable, as Sam Tour pointed out, if the term hardness could be defined, or some new one invented to which could be ascribed some definite physical property, thus having a connotation free of the many shades of meaning associated with our present word. Unfortunately, all of our present tests are called "hardness" tests, even though they obviously measure different combinations of qualities, so different that correlation is quite impossible.

Metallurgical Education

A symposium on metallurgical education under the chairmanship of Prof. S. L. Goodale, of the University of Pittsburgh, brought out many suggestions from practicing engineers on "What to Teach" and in return educators told how the colleges were meeting these new demands. Both parties were agreed that the basis of a sound metallurgical education was a solid foundation in the great art of language and the fundamental sciences—mathematics, chemistry and physics. University professors were apparently unanimous in the belief that the technical student should also give much more attention to the so-called "humanities"—ancient languages, literature, history and fine arts—and the newer studies, economics and psychology. In fact, the demands upon the modern engineer, first as a citizen, and then as a specialist, appear to require such thorough preparation that there is a distinct trend toward the 5-year course. In this additional year of college life the student could really specialize in his chosen field, already having been fitted by a much more general education to enter any one of several engineering specialties. Undoubtedly such a 5-year course, properly taught, would make better engineers and better citizens, but it was recognized that such an innovation would have to be approached with care, in view of the present unpopularity of a lengthy college course. On the other hand, it was pointed out that nearly if not quite all university curricula in metallurgy were offshoots of schools of mines or of chemical engineering and contain many studies which have only a remote bearing on metals and their alloys. If these excrescences could be removed—or in other words, if a real metallurgical curriculum could be established—there would then be available no small amount of time for "humanities" without extending beyond the conventional 4 years' time.

There is of course one very important kind of metallurgical education which lies beyond the university. It consists of teaching artisans—machinists, toolmakers, blacksmiths, forgers and heat-treaters—as well as foremen and executives—something of the great advances which are being made in the art and science of alloys. Many of these men can never be reached, because of their own mental stagnation. On the other hand, the American Society for Steel Treating, through its frequent local meetings, the technical press and the trade and continuation schools, is doing a great deal for the younger and more ambitious men engaged in manufacturing metallic goods. Much leavening of this whole mass is being done by the graduate metallurgist himself. When he enters a plant he finds his activities touch many of the operating, executive and selling departments, and, if he is the right sort, he preaches the gospel of "quality" in metal in season and out.

Handling the Finished Products of Industry—V

Handling Bricks From Kilns for Storage and Shipment Is a Problem Easy to Solve—Why Modern Methods Have Not Been Generally Adopted in This Industry—Suggested Solution Based on Experience of American Enameled Brick & Tile Co.

BY GRAHAM L. MONTGOMERY

THE OPERATIONS in the average brickyard are particularly adapted to the successful application of mechanical handling equipment. The basic raw materials are few in number and are received in relatively great bulk. The additional materials used are of such small bulk that the means used for handling them is unimportant. In the treatment of the material for manufacturing the brick, from the first operation which the raw material undergoes to the point where the burned brick is removed from the kiln, we have a manufacturing process which is ideal for the application of straight-line flow and automatic handling methods. After the bricks leave the kiln, whatever the design of the kilns may be, they are products of a form which permits the simplest and most economical type of handling.

The conveyor engineer or the experienced conveyor salesman can hope for no easier job than that of laying out a handling system for handling finished brick. The product is uniform in shape and weight. The sources of origin—the kilns—will be approximately all in the same location. Any intermediate operations which may happen to the brick, such as sorting and storage, will happen to all of the products, and may easily be arranged to occur in a straight line between the kilns and the point of shipment. Since the product is entirely uniform, the method used in shipping will be exactly the same, and therefore presents a splendid field for the application of mechanical carloading equipment.

STATUS OF HANDLING FOR FINISHED BRICKS

In spite of these considerations, there is scarcely a brick plant in the country which is taking full advantage of the saving to be made through the use of this mechanical equipment. Some plants have made a beginning and have applied conveyors here or there; and the plants that have done this have found they derive a distinct advantage from the use of these machines. A large majority of plants, however, have failed to take any advantage whatever of equipment of this type for handling the product at any point beyond the kilns.

ATTITUDE OF SOME CERAMIC ENGINEERS

Perhaps the reason for their attitude is explained by the attitude taken by some of the leading ceramic engineers of the country. As an example of the attitude which these engineers take I quote from the work of Ellis Lovejoy on "Economy in Brickyard Construction and Operation." Mr. Lovejoy in his chapter entitled "Drawing and Loading" writes as follows: "We wish to express our respect for the wheelbarrow. We have little use for a wheelbarrow in handling clay, but in handling the burned product, the wheelbarrow makes a brave showing in competition with any other method."

When engineers who are presumably leaders in their field write in this manner, it seems hopeless to look for

an appreciation of modern equipment on the part of those whom we may assume to be under their guidance. The situation is not, however, as bad as this might lead one to believe. There is at the present time a distinct shortage of cheap, unskilled labor. For this reason many of the brickyards, in order to produce and ship any product whatever, are under the necessity of adapting some mechanical means of handling. The wheelbarrow, which Mr. Lovejoy admires so much, was undoubtedly an economical appliance in the days of free immigration from Europe. Under present conditions the unskilled laborer, when it is possible to hire one, wants almost as much for his day's work as the most skilled man in the plant. For this reason operators of brickyards are thoroughly aware of the fact that they must revamp their methods in such a way as to abolish the horde of wheelbarrow pushers which at present characterize this industry.

HANDLING AT AMERICAN ENAMELED BRICK & TILE CO.

As an example of what has already been done in handling finished brick, the plant of the American Enameled Brick & Tile Co., at South River, N. J., is suggestive. The methods already established and working at this plant indicate a simple extension to complete mechanical handling. This extension could be made without any change whatever in the plant layout, and would necessitate only a slight change in the operating methods now in vogue.

The products of the American Enameled Brick & Tile Co. consist of brick and tile having one or more white porcelain enameled faces—such material as is commonly used for engine rooms, basements and swimming pools. Bricks of this type are among the most difficult to handle. Any unduly rough treatment is sure to damage the enameled face. It is also necessary to subject these bricks, after they leave the kiln, to a most searching inspection. Only those bricks which are absolutely without flaw can be sold as first-grade enameled bricks. Bricks having cracked enamel or other defects must be separated out, classified and sold as seconds or thirds.

HOW HANDLING EQUIPMENT WAS FIRST USED

The management of this company had considered the installation of conveyors for many years, but with the consideration of their particular difficulties in view, they did not feel that this equipment could be installed and used without resulting in more damaged product. During the war this plant went extensively into the manufacture of firebrick for the government. This required no change-over in the arrangement of the plant, as the base material from which the enameled brick is made is the same as that from which firebrick is manufactured.

Due, however, to the fact that they had no problem of enameled faces to deal with, it was thought that greater efficiency could be realized in the face of the labor shortage by installing conveying equipment for unloading the kilns and for taking the brick from storage and other points to the cars in which they were shipped.

*Previous articles in this series have appeared in *Chem. & Met. Eng.* as follows: Article I, vol. 26, No. 18, p. 823, May 3, 1922; Article II, vol. 26, No. 19, p. 885, May 10, 1922; Article III, vol. 26, No. 24, p. 1,114, June 14, 1922; Article IV, vol. 27, No. 5, p. 199, Aug. 2, 1922.

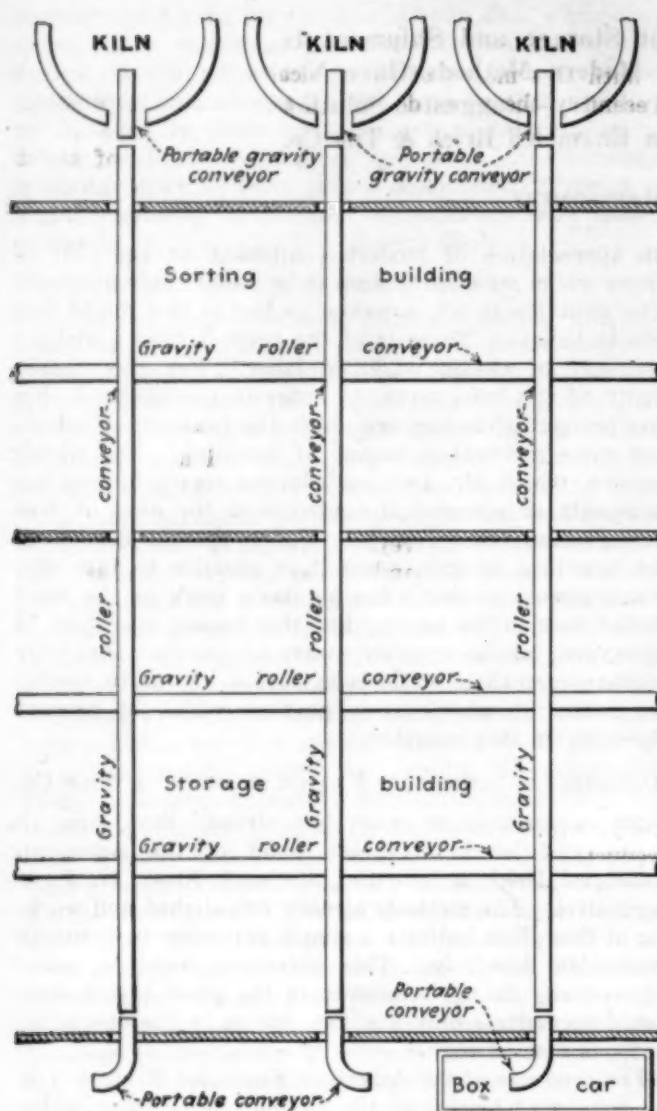


FIG. 1—DIAGRAMMATIC LAYOUT OF HANDLING SYSTEM FOR BRICK FROM KILNS TO STORAGE AND SHIPPING

Consequently, gravity conveyors were installed for this purpose.

LAYOUT OF THIS HANDLING EQUIPMENT

Reference to Fig. 1 gives a diagrammatic idea of the layout of the kilns, the storage space and the location of the shipping track. This sketch is not an exact reproduction of the plant, but does give the relative position of these various elements. The space on the sketch which is marked "sorting building" is used in the production of enameled brick for sorting the brick into the various grades in which it is sold. After the sorting is accomplished, the bricks are taken into the storage building and piled to await shipment. When shipment occurs, they can easily be taken through the doors of the storage building directly into the cars in which they are to be shipped.

This handling was formerly accomplished in two ways: Between the rows of kilns and extending into the sorting building are industrial railway tracks; at right angles to these tracks extending between the kilns in the other direction and extending up and down the floor of the sorting building are other industrial railway tracks. By means of a transfer car, then, the bricks could be unloaded from any kiln and taken to any position in the sorting building where they were to be

sorted. After the sorting they were loaded on hand-barrows and wheeled to the required position in the storage building or directly into the car if shipment was to occur immediately.

The industrial railway, such as described above, is a common type of handling equipment used in the few plants which have installed any handling equipment at all at this point. This apparatus is quite flexible enough for the service and is fairly cheap to operate. But its operation either requires power in the form of a storage battery locomotive or requires that the cars be pushed by one, two or three men, depending on their weight. Of course, these men may not all be necessary to push the car along a straight run of track, but at the transfer point their services cannot be dispensed with. It is plainly good business to dispense with this extra labor if possible.

HANDLING FIREBRICK

In handling the firebrick, it is evident that the brick can be taken directly from the kilns to storage or to the cars by gravity conveyors. The kiln floor is some distance above the floor of the manufacturing building. This is because of the fireboxes and flues of the kiln, which are on the floor level, the kiln floor being above these. This permitted sufficient slope to be given to a gravity conveyor to run the brick directly across the sorting and storage buildings into the cars.

This routine worked very well with the firebrick where there was no necessity of sorting prior to shipment and where the product was of such a nature that it was not necessary to take particular care in handling it. In practically every plant manufacturing common building brick or firebrick, this system can be applied, if the plant layout is of the straight-line type. Where the necessary drop in the gravity conveyor is not available, it is a simple matter to depress the loading track. The expense entailed in such depression would easily be covered by the wages of the wheelbarrow pushers who would be dispensed with by this course of action.

SPECIAL CARE NEEDED TO HANDLE ENAMELED BRICK

When it comes, however, to the handling of products such as face brick and enameled brick, where the purchaser desires a definite standard of perfection, the brickyard is faced with a more difficult problem. There seems to be a general doubt among superintendents and managers of plants of this type as to the possibility of handling their product on conveyors of any type without damaging it in some way.

At the present time, at the American Enameled Brick & Tile Co., the enameled brick is handled in two ways. The usual way is approximately as follows: A short run of portable gravity conveyor is placed to extend from within the kiln to a point adjacent to the nearest industrial railway track. The men in the kiln place the bricks on this conveyor, and the men at the other end remove them and place them on a rack-car on the industrial railway. This operation is completed without any damage whatever to the brick. In fact, there is much less damage than there would be if the brick were loaded directly from the kiln to the industrial railway car by hand, as several passages of the brick from hand to hand are eliminated.

SORTING FACE BRICK

After the industrial railway car is loaded, it is pushed by hand along the track and taken by means of the

transfer car to the desired position at a sorting table in the sorting building. The bricks are here sorted and piled according to the various gradings in vogue. They are taken from this sorting building to the storage building, or in some cases directly into the cars, on hand-loaded, man-pushed wheelbarrows. From the storage building, they are more often loaded into the cars by a second portable gravity conveyor. In this case, the men pick up the brick from the pile in the storage building, several at a time, place them on one of the papers which are used to separate them in the box-car and permit this package to run down the gravity conveyor into the car. This work also is accomplished without any damage to the bricks—that is, provided the men who are handling them take sufficient care in placing them on the conveyor and removing them from it. By sufficient care it is not meant to imply that such extreme care is necessary as to slow up the operation. It is only meant that the handlers shall not carelessly knock the faces of the brick against one another, or against the framework of the conveyor.

FULL CONVEYOR HANDLING FOR FINISHED BRICK

At other times when conditions are right in the plant, a full run of conveyor is placed directly from the kiln into the car. In this way, by having the bricks pass slowly through the sorting building, it is possible to select from the conveyor all those grades which are not to be shipped in that particular car and to permit only the desired grade to continue on through the storage into the car should it be desired to sort in this way. The flexibility of application of this system is evident, as it is possible at any time to stop the bricks at the sorting place, at the car, or any other desired point in the plant merely by the extension of the portable gravity and by the introduction of a few small power boosters.

Referring again to Fig. 1, we see there the possible ideal extension of this gravity handling system by the application of fixed conveyors. The three runs of gravity conveyor extending across the page and the three runs extending perpendicular to them could well be permanently installed. By the application of switches at the intersection of these conveyors and by using portable conveyors to connect the permanent conveyor to any kiln, to load or unload bricks to or from the permanent conveyors at any portion of the sorting or storage buildings, and to take the brick from the end of the permanent conveyors into the cars, a system would be established which would eliminate all possible rehandling of the brick from the time it left the kiln until the time it left the plant.

OPERATION OF FULL CONVEYING SYSTEM

To operate such a system, it would be necessary to develop a certain routine and technique so that the brick would move regularly and without damage. But no matter what the handling system used may be, there is a routine and a technique of some kind which must be developed in the handling. It is evident in any case that the fewer the number of rehandlings which the brick undergoes the less chance it has of being damaged. Experience proves that brick cannot be damaged while it is passing along the conveyor, if it is placed on the conveyor in a correct manner. The majority of the damage seems to have occurred in the past when the brick was passed from hand to hand in unloading the kiln, when the brick was placed on the barrows in the

sorting or storage building and when the brick was again passed from hand to hand in the car.

With this means of mechanical handling as used at present in the plant described, there has been effected an increase in the number of bricks which a given number of men could handle in a given time of about 20 per cent. If such an increase can be effected by a partial application of the system, the savings effected from a full and judicious use of this type of conveyor should be even greater and more worth while.

The writer wishes to acknowledge the courtesy of the American Enameled Brick & Tile Co. in making available the data on which this paper is based.

Production of Clay for Sale Decreases in 1921

The output of clay mined and sold as clay in the United States in 1921 was 1,716,746 tons, valued at \$6,025,300, or \$3.51 per ton, according to the United States Geological Survey. This was a decrease of 45 per cent in quantity and 48 per cent in value as compared with 1920. These figures represent only clay sold as clay by the original producers; they do not include the much greater quantities of clay burned into clay products by the producers themselves.

The production of kaolin, the clay that is used in making high-grade pottery and porcelain as well as paper and other products, was 162,726 tons, valued at \$1,579,163, a decrease of 39 per cent and 45 per cent, respectively, as compared with 1920. The clay of largest production and value is fireclay. The sales of fireclay in 1921 amounted to 1,195,861 tons, valued at \$3,560,373, a decrease of 49 and 52 per cent, respectively, as compared with 1920. The output of every kind of clay as classified by the Geological Survey in its statistical report decreased in quantity and value in 1921 as compared with 1920.

The imports and exports of clay also decreased in 1921 as compared with 1920.

Factors Affecting Yield of Carbon Black

Factors of utmost importance in the efficient recovery of carbon black from natural gas are the design of a plant, the kind of lava tip used, the distance from the depositing surface to the top of the lava tip, the arrangement for admitting air and the rate of movement of the collecting surface. Provision should be made in construction for changing the height of burners, as different gases require different distances below the depositing surface. In West Virginia the lava tips are about 3 in. below the channels, but in Louisiana this distance is too great. By changing the position of the lava tips, one company in Louisiana increased its production of carbon black 20 per cent. If the tips are placed too near the collector, the flame tends to pass around the surface and loss of carbon black in flue gases increases. The rate of actuation of the depositing surface affects the quality of the carbon black manufactured more than it affects the quantity recovered. This factor, therefore, is determined by experiment; it is one of the flexible features, whereby various grades of black may be made by using the same method. The devices for admitting air are controlled by using as an index the color of the smoke issuing from the buildings, the superintendent having in mind the quality of black to be made and compensating losses in flue gas according to the quantity of black recovered.—*From Bulletin 192 of the Bureau of Mines.*

Sulphuric Acid Recovery In Oil Refineries

BY LEWIS B. SKINNER

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IN THE early American practice recovered sulphuric acid was evaporated in lead pans to a strength approximating 60 deg. Bé. and then brought to 66 deg. Bé. in a number of glass retorts or stills, each having an average capacity of about 40 gal. The lead pans, in series, were fired by a number of oil burners. The glass retorts were fired separately and individually, and the waste heat from them was passed generally to the pan flues.

Each retort was bedded in sand, so as to furnish a uniformly distributed support for such fragile material, since, if improperly carried, the swirling and bumping of the acid would be likely to break the glass. The upper part of the still projected above the arch of the firebox to such an extent that the top level of the acid was above the brickwork after the original charge had been reduced in bulk by the concentration. Each retort was charged with 60 deg. Bé. acid from the pans. After the acid had been evaporated down to 66 deg. Bé., it was siphoned off and the retort recharged. All these operations required careful and experienced manipulation.

Dilute sulphuric acid may be evaporated by heat up to a certain point without loss, unless substances are present which cause decomposition. The dilute evaporating mixture does not reach a boiling point approaching the melting point of lead or possess chemical activity of such a pronounced nature as to rapidly destroy the metal until a strength above 60 deg. Bé. is attained. Lead pans may therefore be used in concentrating part of the way, and condensation of the distillate produced is not required. The evaporation above 60 deg. Bé. is attended by a loss of acid as well as water, so that it is necessary to collect and recover the fume or distillate. Each still was provided with a glass connector set in a hole at the top, for the purpose of delivering the vapors to one of a number of openings in a lead condenser pipe, ordinarily submerged in water in a lead-lined, wooden box. Cooling water was fed at the end of the condenser system farthest from the stills and removed at the hot end.

PLATINUM STILLS GIVEN A TRIAL

In the early days, the oil refineries usually shipped their separated acid to the chemical manufacturers for concentration but, in spite of the careful attention given, it was found that the intermittent style of operation, the breakage of glassware, the high cost and uncertainty of the material and the man-handling required made the concentration too costly. Platinum stills having lead covers and arranged in series to run continuously were tried, but it was felt that the high cost for interest on investment and for amortization, along with lesser evils, made such equipment undesirable, so cast-iron stills were introduced.

CAST-IRON STILL WITH LEAD COVER

Eventually, all the chemical plants abandoned the glass retorts in favor of cast-iron stills. These were provided with lead covers, somewhat pyramidal in shape, over which cooling water was cascaded. Later, the oil refineries adopted this style of equipment themselves, feeling that they should eliminate the expense

of handling and freighting the water in the weak acid, and also avoid the cost due to the corrosion of ordinary metals when shipping such material in bulk.

The design handed over by the chemical manufacturers has been largely adhered to in later built refineries until quite recently. Now, however, there seems to be a desire to get rid of a method which is particularly obnoxious when large tonnages are to be handled. Such layouts are undesirable because the stills are small, because the water-cooled lead covers abstract heat from the acid being concentrated below, because the leadwork requires almost constant attention from high-priced mechanics, because neither the latent nor the sensible heat transmitted to the distillate vapors is conserved, because of the slopping about and the cost of the water used for cooling and because of the high consumption of fuel oil.

Having designed and built a number of pan-and-still sets, the author does not recommend the complete abandonment of this style of apparatus. There are situations where the desirability of its use is indicated. With a relatively low first cost in its favor, the arrangement, properly modified, may be employed to advantage, either when small quantities of acid per day are to be concentrated or when tenure of life for the plant is not reasonably assured, or when sludge acid is not produced regularly or at a reasonably uniform rate. A low-cost standby for peak tonnages should be available in addition to the regularly run equipment.

IMPROVEMENTS IN CAST-IRON STILL AND ACCESSORIES

The modifications or improvements consist in the use of large stills, cast-iron covers, a small, packed, heat-exchange tower, to which the fumes from the stills are taken by a slight suction and condensed by contact with the cold acid being fed to the system, and a rigid form of construction which does not permit the bulging ordinarily produced by acid stills. The small tower cuts down the quantity of fuel oil required when water-cooled condensers are used, because it provides for the efficient utilization of approximately one-half of the heat delivered to the stills, which heretofore has been wasted in the vapors. It does away with that part of the pan area formerly needed to bring the feed acid from its cold state to the temperature of actual evaporation. It renders unnecessary a cumbersome condensing system with its attendant repairs and the demand for a supply of condenser water, and it avoids the nuisance arising from the leakage of fume from the numerous joints of a condenser train.

Since the strength of the pan acid delivered to the stills is usually 60 deg. Bé., and this, when concentrated to 66 deg. Bé., produces a given amount of fume and requires a definite amount of heating surface, the size of the tower and stills can be fixed, but the area of the pans must be varied to suit the strength of the weak acid to be fed and the amount of organic matter to be contended with.

To obtain 20 to 25 tons of 66 deg. Bé. product from 35 deg. Bé. feed acid, an oil-fired plant should have eight lead pans in series, of a combined area of about 1,200 sq.ft.; two cast-iron stills of about 50 sq.ft. and a condenser tower about 5 ft. square, lead to lead, and 18 ft. high.

Since pan-and-still layouts should evaporate the water from the surface of a weak acid instead of distilling it through a scum, the mixture of oil and carbon that

forms on the surface of the liquid should be skimmed regularly throughout a shift, the routine to be adopted depending upon the kind of material being run. To evaporate below the boiling point, advantage should be taken of the physical law that liquids in contact with foreign gases are affected in a general way as though in a vacuum. A stream of gas passed through a liquid produces the effect, at the surface of each bubble, of a tiny vacuum pump. A rapidly changing atmosphere, acting upon the film at the surface of a liquid body, has the same effect. Therefore, in order to get the benefit of the contact of the water in the weak acid and the atmosphere, the viscous, semi-solid, floating organic matter should not be allowed to interpose itself any longer than necessary. Provision should be made for ready access to every one of the lead pans.

The organic matter present reacts with the sulphuric acid and decomposes it. The effervescence of the fixed gases formed produces a mist, so that working over the pans in the atmosphere created is certain to be undesirable even under the best of conditions, and particularly so when the plant is a large one. To overcome this and the other objectionable features of high repair cost of burnt out pans, time lost in such repairs and in replacing stills, high fuel consumption and other annoyances, the author designed tower concentrators, arranged in a special manner.

The Skinner Tower Concentrator

For sludge acid, a plant consists of four towers; one for evaporating weak acid without condensation of the vapors, since they do not contain sulphuric acid; one for bringing the partially concentrated acid to 66 deg. Bé., wherein fume is produced; and two in series connected to the strong concentrator, for condensing this fume.

The strength to which the feed acid is brought in the evaporating tower depends upon the kind of oil-treating that has been done. The temperature applied in the tower and the elimination of a part of the water causes, in many cases, a separation of oily matter without a noticeable decomposition of the acid. To furnish some idea as to the part of the work done in this preliminary treatment, it appears that a concentration to 50 deg. Bé., approximately, works well. However, the great variety of products treated and the changes in oil-refinery practice do not permit of a definite statement. This is not a serious matter in considering the plant engineering and may be settled by observation of plant-running, in co-operation with laboratory research.

Heat is applied by direct contact of products of combustion with acid, the gases being furnished at a high temperature from a firebox attached to the tower at its base. Draft is induced by an exhaustor requiring very little power, since the tower itself has a pronounced chimney effect. Carbon should not be introduced into the acid by the fire gases. In using fuel oil, this is guarded against by having two arches in the firebox, which zigzag the gases before entry into the tower. When coal is used, the result is attained by a specially designed underfeed stoker.

The evaporating-tower product is led to coolers and separating tanks where the oily matter is continuously skimmed from the acid to be further concentrated.

The strong-acid concentrating tower is built more substantially than the weak-acid tower, inasmuch as it is subjected to much greater punishment. The con-

denser towers, are arranged in a rather simple manner, since they are not subjected to high temperatures and pronounced corrosion.

For work of this character, it has not been the author's experience that capital expenditure is lessened as a result of constructing towers of special acid-resisting brick or other shapes. The laying of such is very expensive, owing to the extreme care required from especially trained bricklayers in fitting tight and close joints, in selecting only bricks which are true to dimensions, and in chipping interminably to make tight fits. In the case of the concentrators, square steel frames are used for supporting lead sheets, the latter being lined with ordinary vitrified brick which are cheap and may be put in place rapidly in acid-resisting cement, by ordinary workmen. The condensers are not lined; it is not necessary and cuts down capacity. The wall lining is of sufficient thickness at the various heights to prevent the high inside temperature from reaching the lead sheets outside. Vitrified bricks, spaced sufficiently far apart to minimize the tendency of the solids introduced with the acid to "bridge across," are used for packing.

TOWER PACKING

The use of broken material of various sizes and shapes is likely to take up solids from the acid and obstruct the draft. Brick packing, spaced regularly, reduces this possibility and therefore provides for higher average daily tonnages. When broken material is used in towers, it is assumed generally that the voids produced represent 50 per cent of the volume of the solids. This may be so at the outset, but dirt settles out readily on the horizontal or nearly horizontal surfaces, eventually closing open passages, with the result that only a few irregular vertical channels are left to do the work. The void area is required to take care of the extremely large volume of gas which must be passed compared to the small amount of liquid so that, even though constricted, the liquid may flow freely enough, while the gas cannot. Washing a tower packed with broken material does not prove very efficacious, because the solids, being supported as indicated, are not readily dislodged, even though a flood is passed for some time.

Relatively massive arches, at a considerable height from the tower base, are used in the concentrators for supporting a short column of packing. Such an arrangement permits the anhydrous ferric sulphate mud to precipitate from the acid when it is raining down, instead of in the packing where it would tend to bridge across the voids and to obstruct the draft. Such a condition develops when the arches are placed down near the tower base, as is generally done. Then too, were single bricks exposed to the destructive influence of strong, hot acid and fire gases at an efficient firebox temperature, as would be the case were the packing supported on arches near the bottom of the tower, they would be cracked and spalled, with the result that the packing would become disarranged and the tower obstructed in a manner not to be overcome by washing. By having the brick checkerwork at the uppermost part only, where it provides for a uniform distribution of the acid fed in, and for a finished heat exchange between it and the ascending gases, cracking or spalling is at least minimized, because, immediately upon entering the tower, the combustion gases are greatly reduced in temperature as a result of coming into con-

tact with a shower of acid. The arches are made massive because, even though the surface brick near the base of the tower crack and spall to some extent, those in the core remain sufficiently intact to support the weight above.

ACID DISTRIBUTION

An acid distributor, consisting of a disk to which the acid is supplied at the center and having any number of equal-sized compartments at the rim, which are connected at their bottoms to sealed distributor pipes with heads of several feet above the tower top, has been found to furnish an equally divided and continuous-running feed, as the main supply is varied. The compartments are formed by the disk rim, by an outer circular rim and by equally spaced division walls which are radii of the circle. The acid delivered to the center spreads evenly in all directions and overflows the disk rim according to the spacing of the division walls. If the pipes are provided with sufficient head to force any sediment which might collect in an "S" bend seal to pass along with the acid, a regular, uniformly divided supply is assured.

"V" slots, weirs, or small holes, generally used for dividing in a variety of distributor systems and depending upon the care and judgment exercised by a towerman in poking or cleansing from the mud or debris furnished by dirty acid, are to be condemned when ease of operation is desired, particularly in view of the uncertainty as to whether, under the best of conditions, the streams can be equal in quantity.

It is important that the strong concentrator, in particular, should have a uniformly divided and continuous-running supply, since, should some part of the packing fail to receive its share of the acid, that part would become dry and overheated and, upon again receiving its quota, might be cracked and spalled. A poor distributing system might permit the acid to shift from part to part of the tower to such an extent as to require that the tower be repacked frequently.

CONDENSING TOWERS

When working normally, the gases leave the strong tower at about 240 deg. F. in a volume corresponding to the products of combustion from regular firebox practice, with the exception of the addition of the condensable vapors. Therefore they are not large in amount and do not require extensive condensing equipment to remove the acid evaporated. The two condensing towers are loosely packed because the acid fed to the concentrator may continuously furnish traces of organic matter to them, and an accumulation might fill the voids of tight packing.

The gases enter the top of the first condenser tower and travel from the base to an acid exhaustor, from which they pass upwardly in the second tower. Since these towers do not have brick walls, they radiate heat freely, but they are cooled further by circulating a part of the distillate which has been brought down to ordinary temperature in coolers. For a production of 25 tons per day, the power required to run the acid fan is not over 3 hp. The distillate produced may average 40 deg. Bé., the strength being regulated to some degree by the amount of cool distillate which is circulated. Thus a material amount of water vapor is passed out of the tailstack.

The evaporating, or weak-acid, tower is constructed in a manner similar to the strong-acid concentrator,

but is not connected to condensing apparatus because the effluent is not brought to a strength which permits the escape of acid with the water vapor.

The strong tower will require washing from time to time, the frequency depending upon the amount of dirt in the acid. This may have to be done as often as twice a month, but the operation is relatively simple and of short duration, in that it consists in turning on a larger acid stream for a period of 4 to 5 hours, so as to make a product of 58 to 60 deg. Bé. instead of 66 deg. Bé. The weak product so made may be delivered to the "partially concentrated" stock tanks, when, after the mud has settled out, the acid may be used along with that fed to the strong tower.

The packing in the strong tower will last in proportion as the bricks used are vitrified, and as care is exercised in maintaining uniform operating conditions, but even should such efficient, economical and low-first-cost equipment as this require repacking in the course of a few years, it does not become a hardship, because there are only a few thousand bricks in the checker-work and six men can do the job in about a week.

A tower layout, such as has been described, for producing about 25 tons of 66 deg. Bé. acid per day, may be put into commission under average conditions, applying in January, 1922, for approximately \$40,000. As industrial conditions improve, this cost may be reduced.

Denver, Colo.

Variety of Chemical Byproducts Tried as Wood Preservatives

A list of the various substances that have been used or suggested for preserving timber from decay would include a surprisingly large proportion of those known to industrial chemistry. Byproducts for which no use could be found have often taken their last stand as possible preservatives of wood. There have been sent to the U. S. Forest Products Laboratory for testing of their preservative qualities the condensed fumes of smelters, the waste liquors of pulp plants, the refuse of tanneries, the skimmed milk of creameries and a wide assortment of compounds under trade names. Very few materials have been found to have value as wood preservatives.

To preserve wood against decay a substance must first of all be poisonous to wood-destroying fungi. Decay in wood is not due to direct chemical action or action of the elements but is always the result of the activity of these plants which feed on the wood and thus destroy it. To prevent fungous infection, the preservative must be able to penetrate the wood thoroughly enough to form a continuous exterior shell of poisonous treated wood deeper than any surface checks which are likely to develop, and to retain its toxicity, or poisoning power, under service conditions.

Safety in handling and use is another important consideration. A wood preservative must not be a dangerous poison to men and animals, a highly flammable substance, or a material injurious to wood. If it seriously corrodes iron, steel or brass, its use is limited because of its action on the treating equipment and on bolts and metal fastenings in contact with the wood in service. Color, odor and effect on paint are sometimes of considerable importance.

Provided a preservative meets these requirements its cost, availability and uniformity will largely determine its usefulness.

Decomposition Processes Applicable to Certain Products Of Coal Carbonization

BY M. J. BRADLEY* WITH S. W. PARR

THE extensive experimental work carried on in these laboratories on the coking of Illinois, Eastern bituminous, Utah, Canadian and many other coals has demonstrated the possibility of increasing the yield of tar oils approximately one hundred-fold, depending upon the variety of coal used in the low-temperature carbonizing process. The distillate obtained in this manner contains a large quantity of neutral, low-boiling, aromatic oils, some of which under normal commercial conditions have a limited application in the industries. For instance, xylene could be obtained in large quantities even under present conditions, if its industrial demand were such as to warrant the expense of recovery and purifying. This hydrocarbon, having a boiling range from 137 to 141 deg. C., has too low a vapor pressure to be an efficient motor fuel, but if by pyrogenic decomposition it can be converted into benzene, which boils at 80 deg. C., its value as a motor fuel is greatly increased. Xylene can also be decomposed in such a manner as to form higher boiling compounds, many being solids at ordinary temperatures. Anthracene and methyl-anthracenes can be obtained in this manner, but, by known methods, in small yields.

In this research an endeavor was made to find out the mode of decomposition and formation of the various products obtained from xylene in order to be able to increase the yields of the desired compounds, and if possible to use this knowledge in working over crude tar oils in order to obtain similar products. In the following experimental work some striking results were obtained which seemed to be directly opposed to those recorded by other investigators.¹ Pure xylene was passed through an electrically heated furnace, at various temperatures, under different pressures and in the presence of such contact surfaces as iron oxides, reduced iron, copper, tin, molybdenum, chromium, the alloy Illium, aluminum, nickel, cobalt, manganese, charcoal, pumice and refractory. The condensible compounds were collected, weighed and analyzed and the non-condensibles measured and analyzed. The vapor condition inside of the furnace was varied by introducing, at the same time with the xylene, air, superheated steam, carbon dioxide, carbon monoxide, hydrogen, nitrogen or ethylene.

APPARATUS USED IN EXPERIMENTAL WORK

The essential parts of the apparatus are shown in the photographs accompanying this paper. The complete outfit, being of a conventional type, requires little explanation, with the possible exception of the furnace.

*An abstract of work carried out by M. J. Bradley in partial fulfillment for the degree of Doctor of Philosophy at the University of Illinois.

¹In order to conserve space, no discussion of other investigations is included in this paper, but a list of articles on the pyrogenic reactions of aromatic hydrocarbons which appeared to be most important in connection with the present problem is given at the end.

An Experimental Study in Which Mixed Xylenes Were Decomposed Under Varied Conditions of Temperature, Pressure and Atmosphere—Effects of Different Contact Surfaces—Identification of Many of the Important Decomposition Products

It was made by taking 6 ft. of 4-in. wrought-iron pipe, threading on flanges and thermocouple pockets and then having these joints acetylene-welded to insure having no leaks under conditions of high temperature and pressure. The caps were cast particularly for this furnace and extended 1½ in. into the end of the pipe and were fitted with three ½-in. threaded openings leading into the furnace.

The pipe was thinly coated with alundum cement, wound in five sections, each having 36.5 ft. of nickel-chromium resistance wire, and again coated with cement. It was surrounded by a wooden box, 20 in. square and as long as the furnace, which contained the pulverized-asbestos and Sil-O-Cel insulation. Each heating element, when connected directly across the 110-volt line, permitted a maximum current of 20 amperes to pass through, but this could be reduced to 5 amperes by means of an external resistance connected in series at the switchboard. At no time was more than 10 amperes permitted to go through the heating elements. By this means the heat of the furnace could be kept constant at any desired temperature between 250 and 900 deg. C.

The top end was fitted with feed pipes for xylene, superheated steam and other gases, also with a pressure and reduced pressure gage. On the exit at the bottom end was a safety relief valve, or constant pressure valve, which could be adjusted to let the gases escape into the line leading to the gas meter at any desired pressure. This outfit has been operated at pressures as high as 180 lb. per square inch. The temperature was measured by means of a thermocouple. The cold junction was kept at zero by means of a Thermos bottle well and ice water, and the e.m.f. was read on a millivoltmeter which had been standardized at known temperatures.

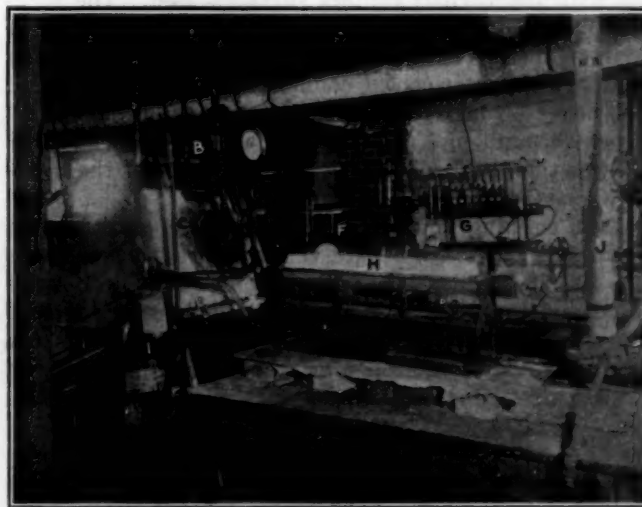


FIG. 1—UPPER END OF FURNACE

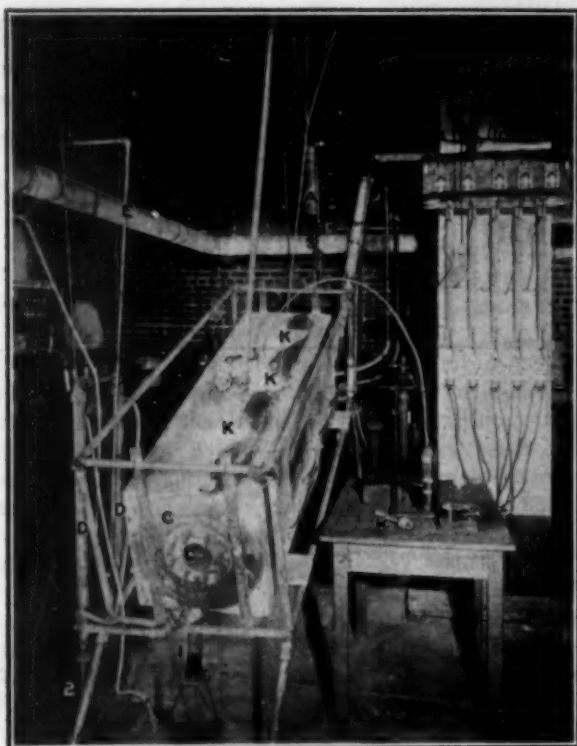


FIG. 2—LOWER END OF THE FURNACE

By this method the temperature could be read accurately within 4 or 5 deg. The thermocouple pockets *K* (see Figs. 1 and 2) extended into the middle of the furnace and thus gave the temperature of the area where the largest volume of vapors passed.

METHOD OF OPERATION

The mechanical arrangement of the apparatus is apparent from the explanation of the progressive steps of a typical run. The xylene was placed in the reservoir *A* (Figs. 1 and 2), fed by means of a regulating valve through the sight-glass or bypass *B* into the upper end of the furnace *C*. Here also could be introduced gas, such as hydrogen, nitrogen, carbon dioxide or ethylene, from the cylinder *I* or steam from the high-pressure steam line *J* could be introduced through the gas-fired superheater *H*. Another attachment, not shown in the illustration, permitted the use of compressed air.

In passing down through *C* the vapors came in contact with the various contact surfaces used. The highest boiling condensate was collected in receiver *I*, the medium oils in No. 2, while the gases, after passing through the water-cooled condensers *D*, were scrubbed with heavy oil in receiver 3. The gas leaving receiver 3 passed through pipe *E* to be measured by the meter *F* and was then burned, or analyzed by means of the modified Orsat apparatus *G*.

When running under increased pressure, extra lengths of piping, fitted with a gate valve, were attached to the ends of the condensers. By keeping the lower valve closed and the upper one open, the condensate collected between them and could be easily removed, by closing the upper valve and opening the lower one, without causing any change in the pressure within the furnace.

METHOD OF ANALYZING PRODUCTS

The condensible products were weighed, fractionated through a 6-in. wash column of glass beads until all the liquids boiling below 145 deg. C. were removed. The

liquid boiling above 145 deg. C., designated in the following results as high-boiling product, was then transferred to an ordinary distilling flask and the fractionation continued until all but coke was driven over. These operations were carried out in electrically heated pot furnaces built to accommodate the particular flask used and maintained at a constant temperature by means of external resistances. Thus each furnace could be regulated so that no distillate would be driven over above a certain temperature. One furnace was used for each cut, up to 105 deg. C.; from 105 deg. C. to 130 deg. C.; from 130 deg. C. to 145 deg. C.; and finally one for the higher boiling compounds. This method saved much time, as it was possible to have several fractionating flasks going at the same time as the furnace and gas analyses.

The solids obtained from the high-boiling oils were purified and analyzed by a combination of various methods as described by Charlton (17), Clark (21), Cook (22) and others (see bibliography at end of article). Partial separation was obtained by making the distillation cuts at various temperatures and then lowering the temperature sufficiently to freeze out the solids. In some cases steam distillation, fractional solution, class reactions and other methods were used to advantage, but these operations are too long to be described in this paper.

The products not removed in the scrubbing process were measured by a standard wet meter and then burned. The sample taken for analysis was collected before passing through the meter. The gases were analyzed by means of a modified Orsat apparatus constructed by the author. It is shown in Fig. 3 with the oxygen and nitrogen reservoir permanently attached to the manifold ready for use and the furnace removed, showing the copper oxide tube. Another modification of this apparatus is shown in a text² describing a number of processes and apparatus developed in this laboratory. The carbon dioxide was removed with 35 per cent KOH solution; oxygen by potassium pyrogallate; acetylene by ammoniacal silver chloride; ethylene by bromine water; aromatics by 20 per cent fuming sul-

²S. W. Parr, "The Analysis of Fuel, Gas, Water and Lubricants," 3rd edition, 1922, McGraw-Hill Book Co., Inc., New York City.

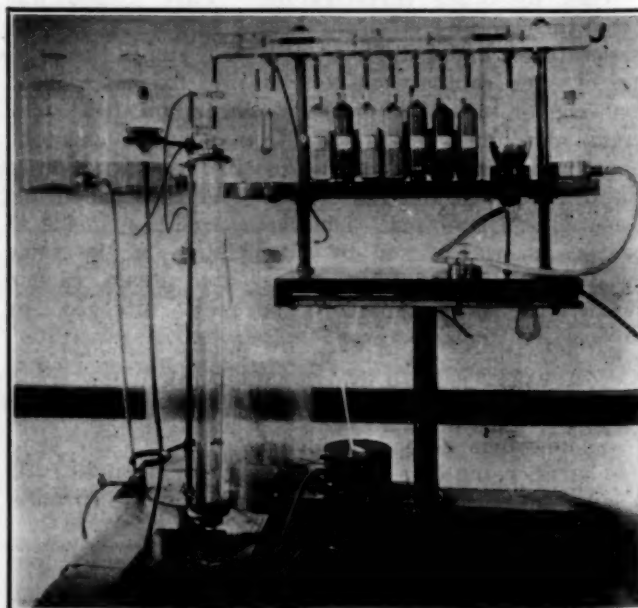


FIG. 3—MODIFIED ORSAT GAS ANALYZING APPARATUS, SHOWING THE WATER-COOLED FURNACE REMOVED

phuric acid; hydrogen and carbon monoxide by combustion with copper and ceric oxides; ethane and methane by slow combustion by means of a platinum coil in pure oxygen; and the nitrogen was estimated by difference.

The gas sample was taken in at the top of the burette and measured at atmospheric pressure by means of twin burettes joined at bottom. The copper oxide tube was made of Pyrex glass and contained about 30 grams of granular copper oxide which passed through a 10-mesh and remained on a 20-mesh screen. To this was added about 0.9 gram of finely powdered ceric oxide, which seemed to activate the copper oxide and greatly to hasten the combustion of hydrogen. In fact, where the carbon monoxide content was low or previously removed by acid cuprous chloride, 70 to 80 c.c. of hydrogen could easily be completely burned in 5 minutes. In the presence of considerable quantities of carbon monoxide the combustion was slower. The combustion tube was frequently oxidized with pure oxygen.

The absorption pipettes contained thin-walled glass tubing to give surface and speed up the absorption. The slow combustion pipette for ethane and methane was made from a 300-c.c. thick-walled Kjeldahl Pyrex flask, which proved very satisfactory. The temperature of the platinum coil was regulated by means of a chromel resistance in series shown on the front of the stand. It is realized that an exact separation of acetylene and ethylene cannot be obtained in the above manner, but by leaving the gases in contact with the ammoniacal silver chloride solution during a constant time interval in each analysis, a relative idea of the two constituents can be obtained. The complete analysis could be made in this apparatus in less than 30 minutes.

SPECIFICATION OF THE HYDROCARBONS

The mixed xylene, which was the commercial product such as is usually marketed in 10-gal. cans, was used in the major portion of this work. After redistilling, it was water-white, contained no suspended material, was free from moisture, had no foreign odor, practically all distilled over between 137 and 142 deg. C. and had a specific gravity of 0.8664 at 15.5 deg. C.

The benzene, toluene and naphthalene used were the commercial product in stock in the chemistry storeroom. They were not analyzed or purified in any manner, as only a few runs were made with them to compare with the results obtained on xylene under similar conditions.

The results on the decomposition of xylene are sum-

marized in Table I and the outstanding features are discussed briefly in the comments on each series.

RESULTS OF TESTS

Each run selected for use in the table is a typical result obtained in a series of eight to twelve similar runs made while the furnace was heated up and with similar conditions inside the furnace—that is, as to contact surfaces and lining. The results are given as obtained for various temperature ranges, different pressures and under the influence of other gases which were introduced into the furnace at the same time as the xylene. The amount of xylene used was 1,000, 500 or 200 grams and was fed through the furnace in 2-hour or 1-hour periods. The sample of gas for analysis was taken when the run was about three-quarters completed. The loss in per cent is given on the basis of the weight of the original xylene; the different fractions of the condensate and coke obtained are given on the same basis. The results tabulated for fractions boiling above 145 deg. C. are not given on a particular run, but on heavy boiling product obtained in several runs in the same series.

A number of preliminary runs between 200 and 600 deg. C. at 50 deg. C. intervals were made on 1,000-gram samples of xylene to see if the iron surface of the furnace would promote any reactions. The loss was less than 1 per cent and the volume of gas was so small that it was not analyzed; the condensate was practically unchanged xylene.

CHARCOAL AS A CATALYST

For series 1, No. 26 being a sample, 2 kg. of wood charcoal, cut in small cubes about $\frac{1}{4}$ in. square, were placed inside of the furnace. The first run was made at 250 deg. C., but no appreciable reactions were noted. As the temperature rose, more gas was given off and contained increasing amounts of CO. Xylene seemed very stable under these conditions up to temperatures above 650 deg. C., when about one-fourth of it was lost. At lower temperatures considerable ethane was found in the escaping gas, while the proportion of methane was small. At 600 deg. C. the ethane content was at its maximum, about 7.5 per cent, and with 20.0 per cent of methane present, but as the temperature rose, the ethane decreased rapidly, while the percentage of methane increased. On the conclusion of the series, considerable carbon, from the decomposition of xylene, was found adhering to the furnace walls.

TABLE I—SUMMARY OF EXPERIMENTAL RESULTS IN THE DECOMPOSITION OF XYLENE

Series.....	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	20	21	25
No. of run.....	26	33	50	61	78	88	94	104	113	125	133	142	151	163	167	286	287	288
Time taken (hr.).....	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Xylene used (gr.).....	1,000	1,000	1,000	500	500	200	200	200	200	200	200	200	200	200	200	200	200	200
Gas put in.....			Air	Steam		H ₂					H ₂					C ₂ H ₄	H ₂	
Pressure, lb.....	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	Atm.	5	125	150
Temp., deg. C.....	750	665	500	650	610	765	700	700	625	665	680	575	600	680	550	610	650	615
CO ₂	0.0	0.0	3.5	25.1	3.8	0.6	1.7	0.7	1.0	0.0	0.6	0.6	0.3	0.4	0.6	0.4	0.5	0.0
O ₂	0.4	0.3	0.3	0.7	2.4	0.4	0.8	0.7	0.9	0.0	0.0	0.6	0.5	0.7	0.3	0.3	0.2	0.1
C ₂ H ₂	0.3	0.7	0.0	0.0	0.4	1.0	1.3	0.6	1.0	0.0	0.3	0.2	0.5	0.3	0.7	0.7	0.3	0.2
C ₂ H ₄	1.7	0.1	0.1	1.2	1.4	2.4	3.0	2.2	9.2	0.4	1.1	1.5	3.4	1.5	4.2	31.1	0.5	0.4
Aromatics.....	2.7	1.4	0.6	2.5	5.4	1.6	2.0	1.2	2.7	0.6	1.6	1.4	1.3	1.0	4.1	0.6	0.6	0.4
H ₂	45.0	71.9	69.9	56.3	40.4	44.5	33.7	53.8	29.4	81.5	33.4	76.7	52.2	72.5	30.8	4.0	58.7	60.0
CO.....	0.7	3.0	5.1	3.0	2.6	13.8	14.8	5.0	3.6	3.4	2.2	4.6	0.4	1.0	0.3	3.1	5.3	4.0
CH ₃ CH ₃	0.8	1.2	4.1	1.0	0.0	0.8	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.8	0.0	0.0
CH ₄	39.4	21.5	7.0	6.6	31.9	35.0	37.4	33.6	58.0	14.1	60.8	12.6	40.4	22.6	41.1	37.0	35.6	34.9
N ₂	9.0	0.0	9.4	3.6	11.7	0.0	3.8	2.2	1.2	0.0	0.0	1.8	1.0	0.0	16.9	0.0	0.0	0.0
Gas, cu.ft.....	8.4	25.6	1.0	5.1	0.7	4.0	2.4	3.7	1.5	9.0	3.3	3.2	2.1	5.0	0.4	10.0	7.4	6.5
Loss, per cent.....	34.0	100.0	66.0	12.0	7.5	63.5	29.0	64.0	27.0	100.0	76.5	45.0	44.0	90.0	14.0	22.3	37.5	26.0
Up to 135 deg. C.....	13.0	.....	.....	.....	0.0	18.0	6.0	2.5	5.0	.....	16.5	2.0	4.0	0.0	1.0	.....	55.5	69.0
105 to 130 deg. C.....	16.0	.....	.....	.....	25.0	12.5	40.0	19.0	25.0	.....	0.0	29.0	30.0	8.0	9.0	.....	0.0	0.0
130 to 145 deg. C.....	19.4	.....	44.0	86.0	63.0	0.0	17.0	9.5	36.0	.....	0.0	20.5	6.0	0.0	71.0	.....	0.0	0.0
Above 145 deg. C.....	16.2	.....	.....	2.0	4.0	6.0	8.0	5.0	7.0	.....	7.0	3.5	16.0	2.0	5.0	77.7	7.0	5.0
145 to 175 deg. C.....	11.2	.....	.....	12.8	.....	45.5	17.7	.....	.....	.....	.....	.....	.....	.....	.....	11.5	.....	.....
175 to 225 deg. C.....	8.8	.....	.....	13.3	.....	4.9	11.0	.....	.....	.....	.....	.....	.....	.....	.....	19.1	.....	.....
225 to 300 deg. C.....	24.6	.....	.....	44.4	.....	16.5	16.7	.....	.....	.....	.....	.....	.....	.....	.....	26.5	.....	.....
300 deg. to coke.....	41.4	.....	.....	20.4	.....	28.3	44.4	.....	.....	.....	.....	.....	.....	.....	.....	38.8	.....	.....
Coke, per cent.....	13.9	.....	.....	8.8	.....	5.0	10.2	.....	.....	.....	.....	.....	.....	.....	.....	4.0	.....	.....

Before commencing series 2, the furnace was cleaned by means of a wire brush and 2 kg. of new charcoal cubes inserted. To insure against leaks, the furnace was subjected to 125 lb. pressure of live steam before heating up. This steaming of the charcoal seemed to activate it so the reactions commenced at lower temperatures, for instance at 550 deg. C. over 20 per cent ethane was found in the outgoing gas and about 25 per cent of the condensate was toluene. At 600 deg. C. the ethane had disappeared and the toluene fraction decreased, while the hydrogen and methane were greatly increased. During the run at 700 deg. C. the temperature of the furnace fell rapidly and a great increase in the volume of gases took place. The furnace became activated in such a manner that the xylene was completely decomposed into gaseous products and amorphous carbon. Run 33 summarizes the results. Several other runs at lower temperatures gave similar products; even introducing hydrogen from a cylinder at various pressures up to 150 lb. did not stabilize the reactions in such a way as to obtain any condensate. The xylene was completely decomposed into hydrogen, methane and carbon.

EFFECTS OF OXYGEN AND HYDROGEN

Before beginning series 3 about 8 cu.ft. of air was passed through the heated furnace; approximately 14 per cent of CO₂ was found in the issuing gases. The air poisoned or deadened the activity of the furnace, with the result that 44 per cent of the xylene was unchanged at 500 deg. C. The air was discontinued during run 50. In this series it was found that charcoal, when heated to 700 deg. C. under reducing conditions and then cooled out of contact with air, would, at ordinary temperatures, take up air readily. On again heating, the oxygen came off as carbon oxides, the dioxide at lower and the monoxide at higher temperatures. It was extremely difficult to remove the oxygen even at 700 deg. C. in the presence of hydrogen, diminishing amounts being given off after several days' treatment.

Before series 4 the furnace had been thoroughly cleaned of carbon and new charcoal added. While heating up it was kept under reducing conditions with hydrogen from a cylinder. During this series considerable toluene was formed, especially at 650, 700 and 750 deg. C. At the latter temperature, under excess hydrogen from the cylinder, a yield of 56 per cent was obtained, while without the hydrogen only 43 to 45 per cent was obtainable. In this case hydrogen seemed to stabilize rather than promote the decomposition of toluene. Superheated steam deadened the activity of the furnace in such a way as to stabilize the xylene passing through, although after steaming and then reducing for a short time the furnace became activated in such a manner as to decompose the xylene completely. This was also found to be true without any charcoal in the furnace. That is, the iron surfaces could be freshly oxidized or activated by means of steam when heated between 600 and 790 deg. C. and after reducing slightly became activated so that the xylene was completely decomposed into carbon, hydrogen and methane. Run 61 shows the results of the first run after passing superheated steam through the furnace; after reducing with hydrogen for a short time, the xylene was completely decomposed, but could be partly stabilized by passing CO or CO₂ into the furnace at the same time as the hydrocarbon. Hydrogen even at 140 lb. pressure

did not stabilize any of the liquid products, once the furnace was in this activated condition. The carbon deposited was intensely black and fluffy, contained some small percentage of liquid hydrocarbon and about 11 per cent of iron, which was found to be a mixture of the magnetic oxide and other oxides, along with very small particles of finely divided metallic iron. It was impossible to tell from these results whether it was the iron or the charcoal surfaces which was causing the complete decomposition of the liquid hydrocarbons.

EFFECT OF METAL FURNACE WALL

In series 5 a lining tube of No. 18 sheet copper was placed snugly in the furnace so that no iron surfaces were left exposed. Copper seemed to have a tendency to decompose xylene into lower rather than higher boiling compounds, as shown in run 78. Oxidizing the copper made it somewhat more active, but on reducing it again complete decomposition of the xylene did not take place. What decomposition did take place seemed to form liquid and gaseous products rather than amorphous carbon, which was formed only in extremely small amounts.

In series 6 the furnace was copper lined and contained 2½ kg. of charcoal cubes. Typical results obtained in this series is shown in run 88. The reactions below 600 deg. C. were unimportant, but as the temperature rose the loss became greater. The loss was cut down somewhat by introducing hydrogen into the furnace, which appeared to stabilize and increase the toluene fraction. However, it was found impossible to activate the furnace and charcoal as described for series 2 and 3.

In series 7 the furnace was copper lined and the contact surface consisted of 3½ kg. of oxidized Illium turnings, mechanically mixed among small pieces of pumice. These runs demonstrated that around 700 deg. C. the decomposition of xylene was greatest and giving the maximum quantity of the lower boiling fractions.

Series 8 was made over small pieces of pumice which had been dipped in nickel nitrate and then reduced at 500 deg. C. with hydrogen. This was to get the metal in a finely divided condition and over as much surface as possible. Several runs were made between 500 and 800 deg. C., run 104 being a sample. Nickel under these conditions did not promote the formation of liquid products, but rather favored complete decomposition of the hydrocarbons into hydrogen, methane and carbon. In fact, the deposited carbon soon filled the furnace so that the series had to be discontinued. At this time the copper lining was found to have become broken in several places, leaving iron surfaces exposed, which no doubt had influenced the reactions.

Before commencing series 9 the furnace was relined with tinned copper, the tin surface being on the inside. Run 113 gives a typical example of results obtained. The series seemed to indicate that in the neighborhood of 700 deg. C. tin promoted the formation of low-boiling liquids. No other contact materials were in the furnace during these runs.

EFFECT OF NICKEL, MOLYBDENUM AND COBALT

Series 10 was run through the tinned-copper lining and using 2½ kg. of charcoal cubes which had been dipped in a thin paste of nickel oxide and dried at 110 deg. C. In this case the nickel oxide and furnace were not reduced before commencing the runs. The results obtained were similar to those of the iron-charcoal

series—that is, the xylene tended to be completely broken down into carbon, hydrogen and methane. Even at as low a temperature as 450 deg. C., 83.5 per cent total loss was obtained. During run 125 hydrogen was introduced at 15 lb. pressure, but did not stabilize any of the liquid hydrocarbons. Small amounts of water were collected in the condensate in every run. The furnace was soon choked up by the deposited carbon. During this series practically all the tin surface scaled off the copper lining.

The next series, No. 11, was run in the copper-lined furnace after over $\frac{1}{2}$ lb. of metallic molybdenum powder had been scattered among the small pieces of pumice stone. As in the preceding series, considerable moisture was collected in the condensate. No appreciable decomposition of the xylene took place below 600 deg. C., but above this temperature the reactions greatly favored the formation of benzene and of methane rather than hydrogen and carbon. Run 133 gives a fair idea of results obtained.

Series 13 was run with the copper-lined furnace containing 5 kg. of 1-cm. cobalt cubes. To reduce all the oxide surfaces the furnace was heated to 500 deg. C. and maintained under 60 lb. pressure of hydrogen for several hours. Even after this treatment moisture was collected in the condensate. Cobalt promotes the decomposition of xylene at low temperatures; even at 450 deg. C. about 35 per cent was lost, and at 550 to 575 deg. C. considerable toluene was formed, as shown in run 142.

MANGANESE AND ALUMINUM

In series 14 manganese in a fine powder was scattered among the small pieces of pumice stone. This metal promoted the decomposition of xylene at lower temperatures than any tried previously and the products formed were liquid rather than gaseous. Run 151 indicates the decomposition products obtained.

In series 15, 440 grams of aluminum powder was scattered among the small pieces of pumice stone and several runs were made at various temperatures. Below 600 deg. C. very little decomposition of xylene took place, but what was changed went to hydrogen and deposited carbon. Run 163, at 680 deg. C., indicates that aluminum does not favor the formation of higher boiling compounds from xylene. It should be mentioned that the copper lining during this series had given way in several places so that some iron was exposed.

Before series 16 the copper lining was removed from the furnace, the latter cleaned by means of a wire brush, reduced while hot with hydrogen and when cold was coated with a lining made by mixing 80 per cent Hytempite with 20 per cent alundum cement. After drying and baking, several runs were made without other contact surfaces. Under these conditions the xylene did not decompose much below 600 deg. C., while above this temperature liquids rather than gaseous compounds were formed. Run 167 gives results at 550 deg. C. and shows the amount of ethylene formed.

CRACKING IN ATMOSPHERE OF ETHYLENE

For series 20 a cylinder of commercial ethylene was connected to the upper end of the furnace. The refractory lining was in good repair and no other materials were introduced for contact surfaces. The preliminary runs introducing ethylene at 45 lb. pressure into the furnace gave some interesting data regarding the stability of ethane, methane and ethylene under these conditions. At 415 deg. C. the waste gases contained 89.4

per cent of ethylene, no ethane and 8.5 per cent of methane; at 475 deg. C. it contained 73.9 per cent of ethylene, 4.6 per cent of ethane and 10.0 per cent of methane. The maximum amount of ethane was obtained at 500 deg. C.; the methane increased with temperature, and at 675 deg. C. the outgoing gases contained 84.1 per cent of methane. Below 475 deg. C. very little decomposition of xylene took place, the loss being less than 5 per cent. In the runs below 475 deg. C. there was always a gain in weight in the liquid condensate, although little xylene was decomposed. This was found to be due to the xylene dissolving considerable volumes of the ethylene, which was readily given off when redistilling. Around 600 deg. C. the furnace decomposed xylene and ethylene very rapidly, the latter going principally to methane. In order to keep the furnace atmosphere mostly ethylene, the pressure outlet gage was set at 2 lb. and the ethylene introduced into the furnace very rapidly. Under these conditions the maximum yield of high-boiling compounds was obtained. The results are given in run 286. Many other runs under various conditions of pressure, rates of feed and gaseous atmospheres were made, but the percentage of higher boiling compounds were lower than in the run tabulated.

In series 21 the refractory-lined furnace was found to decompose xylene as described for series 16. It was now desirable to see if the lower boiling liquids could be stabilized by deliberate control of the gaseous atmosphere inside the furnace. In run 287 the furnace was maintained under 125 lb. pressure with hydrogen from a cylinder while the xylene was being introduced. The results indicate that the major portion of the xylene was decomposed into lower boiling liquids.

In series 25 the low-boiling liquids were slightly increased by increasing the hydrogen concentration in the furnace. The maximum yield is shown in run 288. This result is calculated from the weight of xylene used, while by referring to the equation $C_8H_{10} + 2H_2 \rightleftharpoons 2CH_4 + C_6H_6$, it is evident that this would equal about 93.7 per cent of the possible theoretical yield. The carbon deposited in these runs was very different in appearance from that described previously. It was a metallic gray color and was granular or sandy, while the other deposits had been intensely black and slightly oily.

RUNS USING BENZENE, TOLUENE AND NAPHTHALENE

The runs with benzene were made through the iron furnace containing 2½ kg. of charcoal, the purpose being to try to check the results of Cobb and Hollings (23). They found that benzene passing through coke heated to 800 deg. C. could be entirely stabilized by means of excess hydrogen. In these experiments it was found that when the charcoal and furnace were activated it was impossible to stabilize the benzene even at 500 deg. C. Pressures as high as 125 lb. of hydrogen per square inch were used. On the other hand, if the charcoal and furnace had been treated with superheated steam, air or carbon dioxide, benzene could be entirely stabilized at temperatures as high as 800 deg. C. with very small pressures of hydrogen.

Cobb and Hollings (23) had found that when toluene was passed through red hot coke it was more stable alone than in the presence of excess hydrogen—that is, hydrogen promoted the decomposition of toluene into benzene and methane. In series 4 hydrogen was found to increase the toluene fraction slightly. Pure toluene was

used under similar conditions and found to be somewhat more stable in the presence of hydrogen, except when the furnace was in the activated condition, when it was entirely decomposed with or without hydrogen.

In making the runs with naphthalene, it was preheated in an electrically heated retort connected to the upper end of the furnace. The naphthalene vapors were carried into the furnace by means of the gases which were bubbled through. It was noticed that practically as soon as the run commenced the temperature of the furnace dropped. Even when the current passing through the heating elements was materially increased, the temperature fell slowly. This would indicate that the reactions taking place inside the furnace were absorbing considerable heat. Another feature, particularly noticeable in the nitrogen run, was that the gas recovered did not equal the amount passed into the furnace from the cylinder, even with the addition of the gas from decomposition of the naphthalene. The charcoal may be partly responsible for this result.

In the runs using carbon dioxide as the carrying gas the product contained a heavy, black, high-boiling oil, some free carbon and a very light, fluffy, red material with very little odor of naphthalene. With hydrogen the product was dark gray, containing also traces of the light reddish material. The product from the nitrogen runs was a compact greenish color and from carbon monoxide the reddish fluffy material formed the bulk of the recovery.

The bulk of the recovered product was naphthalene, with small amounts of benzerythrene and α -methyl-naphthalene. A considerable amount of β - β -dinaphthyl, m.p. 187-8 deg. C., was obtained and identified by the picrate, m.p. 183 deg. C. The α - α and α - β forms were present in very small amounts.

GASEOUS PRODUCTS SYNTHESIZED

The process of decomposition of hydrocarbons can never be regarded as a simple effect of heat, independent of contact surfaces and the gaseous atmosphere in which it is conducted. The way in which we were able to modify the results of decomposition in various directions was by the deliberate control of these two factors. The gaseous products obtained in these experiments were extremely important and played as important a part in the final products as the gas introduced. Their effects can be considered from two standpoints—mechanical and chemical. An inert gas, like nitrogen, would not enter directly into chemical reaction under these conditions, but would play a very important part by washing the products of decomposition from the surface of the contact material, assist their volatilization by lowering their concentration in the vapor phase, and hurry them away from the region of decomposition. In the case of hydrogen, being much lighter, it has a greater diffusing power, the molecules travel at a higher speed and thus penetrate small areas where the larger gas molecules never reach. The all-important action of hydrogen, however, is chemical. It tends to reduce the single ring benzene hydrocarbons to benzene itself. A similar action may be inferred, as is very probable, on the attached groups of more complicated ring structures resulting in the formation of naphthalene and anthracene. It seems that this was the part played by hydrogen in the majority of the experiments carried out. However, other factors must be able to modify this

tendency of hydrogen, because in the experiments giving the largest yields of the toluene fraction it was found possible to increase this fraction by introducing hydrogen from a cylinder. It was possible to change the production of hydrogen in these experiments by changing the temperature or the activity of the furnace.

Methane could also be produced in varying quantities, depending upon the furnace conditions. Bone and Coward (24) concluded that methane decomposes chiefly directly into hydrogen and carbon, the process being reversible and a surface phenomenon at least up to 1,200 deg. C. At the temperature these experiments were run methane is practically stable and its chemical reaction would be negligible, but its mechanical action would be very important, as in the case of nitrogen.

The carbon dioxide formed was in small quantities and was always in equilibrium with carbon monoxide. They seemed to deaden or poison the activity of the furnace, although it is possible CO₂ caused partial combustion.

Acetylene was formed in small quantities and although many investigators claim that the building up process is through the ability of acetylene to polymerize, it was concluded from these experiments that acetylene played a very small part. At higher temperatures it was more likely to be decomposed to carbon and hydrogen than to be built up.

ETHYLENE FORMATION

The production of ethylene in these reactions was very desirable, because it was noticed that wherever the percentage of ethylene in the outgoing gas approximated 3 or 4 per cent, the yields of the higher boiling compounds were appreciably increased. In general, it was found that ethylene decomposed into a mixture of ethane and methane in the neighborhood of 500 deg. C. Above 500 deg. C. the ethane content gradually decreased and around 650 deg. C. disappeared entirely with a resultant increase in methane. Ethylene seems to be able to decompose in several ways, which no doubt explains its usefulness in the building up process.

Bone and Coward (24) concluded that the primary action of heat on ethylene is to eliminate hydrogen. The residue $\equiv\text{CH}$ thus formed may decompose or be hydrogenated to methane, or it may unite with another such residue to form acetylene. Hollings and Cobb (23) found that at lower temperatures, around 800 deg. C., it decomposed into methane and acetylene, while at higher temperatures it went into methane and hydrogen.

In some of these experiments as high as 15 per cent of the waste gas was found to be ethane. It was also found that very little ethane was formed below 475 deg. C. and that it was all practically decomposed at 700 to 725 deg. C., except in the presence of steam, which seemed to stabilize it at slightly higher temperatures. These temperatures are far lower than found by Hollings and Cobb (23), who found that the decomposition of ethane was rapid but not complete in 46 seconds at 800 deg. C. At 1,100 deg. C. only 88 per cent was decomposed, the chief products being ethylene and methane. No doubt the molecular decomposition of ethane played an important part in these experiments. According to J. J. Thomson (25), such residues as $\equiv\text{CH}$, $=\text{CH}$, and $-\text{CH}$, may exist momentarily in the free state. The four possibilities open to the residue $=\text{CH}$ are: (1) To form ethylene by uniting with another similar residue; (2) to break down into carbon and hydrogen; (3) to be hydrogenated

to methane; (4) to attach to some heavier molecular formation—a partial decomposition of the benzene nucleus or homologs.

The above is only a partial list of the gaseous constituents in the furnace atmosphere during decomposition; undoubtedly many more complex groups or radicles from the higher boiling compounds exerted an important influence on the decomposition processes.

LIQUID HYDROCARBONS IDENTIFIED

Some of the liquid hydrocarbons which were purified and definitely identified by physical contents or known derivatives are listed below. Other compounds were obtained but have not been identified.

n-Hexane, b.p. 68 deg. C., was obtained in the ethylene series of runs in considerable quantities along with an unsaturated hydrocarbon, which had very similar physical properties, probably hexylene. They were partly separated by the usual methods and the last traces of the unsaturated compound were removed by selenium oxychloride. This reagent reacts too violently to use, however, where any considerable quantity of the unsaturated compound is present.

Cyclo Hexane, b.p. 80 deg. C., was obtained in small quantities, and after a partial separation from benzene, was purified by the above reagent. However, a solution of benzene in selenium oxychloride will readily dissolve cyclohexane. In cases where only traces of benzene were present the separation was rapid and complete.

Benzene, b.p. 80.5 deg. C., was obtained in several runs. The maximum yield obtained was 93.0 per cent of the possible theoretical.

Toluene, b.p. 110 deg. C., was obtained in many of the runs over charcoal. The maximum yield of the crude product was about 66.0 per cent of the possible theoretical.

a- and β-Methyl-Naphthalenes, b.p. 240-3 deg. C., were identified by the picrate, m.p. 112 deg. C.

Di-Tolyls (mixed), b.p. 275-8 deg. C., were identified by the acid derivatives. They were oxidized by prolonged boiling in chromic and glacial acetic acids.

1,2-Dimethyl-Naphthalene, b.p. 262-4 deg. C., was identified by the picrate.

Diphenyl-Ethane, b.p. 286 deg. C., was obtained in small quantities.

SOME OF THE SOLIDS OBTAINED

The solids synthesized were numerous and complex. In a single series of runs the high-boiling constituents were very similar, but in different series the variation was marked. In the series using cobalt and manganese the high-boiling oils contained a larger percentage of solids containing anthracene. The partial list follows:

Diphenyl, m.p. 70 deg. C., was obtained in considerable quantities in the fraction boiling from 340 to 255 deg. C. On standing, it settled out as a white solid. This compound could come from two benzene molecules with the liberation of hydrogen. Dufton and Cobb (18) have proved this to be a reversible reaction by passing diphenyl and hydrogen through a hot silica tube and producing benzene.

Naphthalene, m.p. 80 deg. C., was obtained in considerable quantities, as closely as could be determined, in approximately 4 per cent yields on the original xylene used. In view of the conflicting reports in the literature concerning the formation of naphthalene at low temperatures and from similar liquids, toluene especially, particular care was taken in the purification and identification of this compound. The presence of stilbene may give a clue to its formation.

Phenanthrene, m.p. 98-100 deg. C., was obtained in small yields. It was difficult to oxidize, but the picrate was easily obtained.

Stilbene, m.p. 124 deg. C., was found in small quantities; apparently it had been mostly condensed to naphthalene.

Pyrene, m.p. 145-7 deg. C., was identified by the picrate, m.p. 220 deg. C.

Methyl-Anthracene, m.p. 200-5 deg. C., was obtained in good yields. Both alpha and beta forms were present and were separated by means of the methyl-anthracene-carbonic acids, which have considerable difference in the melting point temperature.

p-Diphenyl-Benzene, m.p. 207 deg. C., was also formed.

Anthracene, m.p. 212-14 deg. C., was formed in considerable yields. It was rather difficult to purify it.

2,3-Dimethyl-Anthracene, m.p. 244-6 deg. C., was purified and identified by the quinone, m.p. 180-2 deg. C.

Chrysene, m.p. 248-50 deg. C., was obtained in small amounts in the runs with ethylene and xylene under high pressures.

Another compound which has been separated is similar to asphaltenes in its appearance, behavior toward solvents, especially ether and hexane, and contains sulphur. The sulphur must have come from the contact surfaces inside the furnace.

SUMMARY AND CONCLUSIONS

Some of the more important results as indicated by the foregoing investigation are given in the following summary:

1. Mixed xylenes were decomposed by heat and contact surfaces, under the stabilizing influence of hydrogen and methane, almost theoretically into benzene and methane. Sixty-nine per cent of the original xylene was converted into crude benzene, which boiled below 100 deg. C. This is approximately 94.0 per cent of the possible theoretical.

2. At slightly lower temperatures, under the same condition of contact surfaces but in a gaseous atmosphere in which ethylene greatly predominated, 77 per cent of the mixed xylenes were built up into higher boiling compounds, the majority of which were solids at ordinary temperatures.

3. Mixed xylenes, under other conditions of temperature and contact surfaces, were converted into crude toluene in quantities approximating 64.0 per cent of the theoretical.

4. Mixed xylenes, under the influence of heat and iron surfaces, were decomposed quantitatively into amorphous carbon and gaseous products. Metallic oxide surfaces, especially after being slightly reduced at temperatures where they decompose xylene freely, accelerate this reaction. Small particles of iron oxides and reduced iron were found in the deposited carbon.

5. The reduced metallic surfaces, or freshly oxidized surfaces at the same temperature are much less reactive and tend to promote partial decomposition.

6. Non-metallic substances such as charcoal, pumice or refractory material at like temperatures tend to decompose xylenes into unsaturated and higher boiling compounds. The decomposition to carbon is materially lessened.

7. Activation of heated iron and carbon surfaces could be induced by treating with superheated steam during a short period and afterward slightly reducing with hydrogen.

8. A deadening effect, opposite in characteristics to the above, was caused when carbon dioxide, carbon monoxide, air or superheated steam was passed through the activated furnace. This condition seemed to be the same, as is ordinarily described, as poisoning of the catalyzer. Under these conditions the liquid hydrocarbons were most stable.

9. Contact surfaces are very important to hydrogenation and dehydrogenation of aromatic hydrocarbons.

10. The gaseous atmosphere in which pyrogenic decomposition takes place exerts an extremely important influence on the yields and products of decomposition. Gases like methane and nitrogen between temperatures of 600 to 700 deg. C. have mostly a mechanical action. Ethylene, acetylene, hydrogen and ethane between the same temperatures have also a mechanical bearing on the end products, but their all-important action is chem-

ical. Ethylene, acetylene and ethane were found to be entirely decomposed at temperatures above 725 deg. C.

11. The decomposition of ethylene was controlled so that practically pure methane or mixtures of methane and ethane were obtained as end products.

12. Pressure under some conditions favors molecular condensation, particularly if the pressure is made up of unsaturated gases. In other cases, where the pressure was made up by hydrogen, it caused the decomposition of the heavier molecules into the single ring compounds. Pressure in all cases lessened the percentage of unsaturated hydrocarbons in the final products.

13. Decomposition of hydrocarbons increases with rise in temperature, the larger molecules being less stable than the smaller ones at temperatures above 700 deg. C. The lower the temperature at which decomposition takes place the more economical the reaction. Lower temperatures can be used in the presence of activated surfaces.

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University of Illinois,
Urbana, Ill.

Use of Bentonite in De-inking of Newspapers Gives Promise of Forest Conservation

Although the de-inking and re-use of old magazines has been practiced for a long time, it has never been possible to apply the process to the recovery of old newspapers, because the strong alkaline solutions used in the process and the subsequent bleaching operation discolor any pulp containing ground wood. These solutions might be reduced in strength and temperature so as not to discolor the pulp and still serve to dissolve the varnish from the ink and free the carbon black. But the carbon particles would then collect in masses which would not pass through the washing screen or would remain enmeshed with the paper fibers. It is therefore necessary to provide some finely divided, colloidal carrying agent in the wash water which will help

gather up the carbon and carry it off. Clays and tales are used for this purpose, but ordinarily they are so coarse that they need to be peptized, or broken up, by strong alkalis at high temperatures before they are effective. It is this requirement that has made it necessary to use solutions in the de-inking process of such strength that they would discolor the ground-wood pulp of which newspaper is made.

Experiments have recently been conducted by the Forest Products Laboratory at Madison, Wis., using bentonite, a very fine cream-colored clay found in Wyoming, as a de-inking agent. Bentonite occurs in finer particles than any other natural mineral substance, and will go into colloidal suspension in water without the aid of strong alkalis. In preliminary de-inking runs made on old newspapers at the Forest Products Laboratory, bentonite was used with an alkali solution just strong enough to loosen the ink without discoloring the paper. It was found that the bentonite particles were so small that they could gather up the freed carbon and still pass through the ordinary washing screen. In the experimental runs, paper fiber matted on the screen and tended to prevent thorough washing; but even with this difficulty a sheet almost equal in quality to the original was obtained.

De-inking trials made later at a Minnesota paper mill, using ordinary paper-making equipment except for a special washing screen, show that the process can be carried out on a commercial scale to produce a sheet which can compete in the open market with standard news.

From 2,500 lb. of old newspapers 2,000 lb. can be recovered by the new de-inking process. In Chicago alone, it is estimated, 325 tons of waste newspapers daily might be economically collected and converted into approximately 260 tons of clean paper ready for reprinting. This would mean a daily saving of the cut on 97 acres of 100-year old spruce wood. The total saving in pulpwood which appears possible through the erection of newspaper de-inking mills in metropolitan centers is equivalent to the cut on 275,000 acres of densely stocked spruce forests yearly.

Wood-Pulp Production and Sales in Sweden

Consul General D. I. Murphy reports that the Swedish output of sulphite cellulose for the first 4 months of the present year, according to estimates from the Wood Pulp Association, amounted to 70 per cent of the normal capacity of the factories.

During this period 75,000 tons was sold, although prices were low and unsatisfactory. Prices recently have been stable, bleached sulphite being quoted at \$80.43 to \$85.79 per ton; easy-bleaching sulphite, \$50.94 to \$56.30 per ton; and strong sulphite, \$38.87 to \$53.61 per ton.

The production of sulphate pulp from January to April of this year was 73½ per cent of normal, or at the rate of about 28,000 tons per year. The strikes at the sawmills throughout northern Sweden, upon which the sulphate mills depend for their supplies, have contributed to the reduction of the output. Sales have recently been reported, quotations being from \$52.28 to \$54.93 per ton both for easy-bleaching and strong sulphate.

Mechanical pulp production during the January-April period of the present year amounted to about 75 per cent of the normal output. Quotations at present are firm at \$30.29 to \$33.51 per ton, dry pulp, but there appear to have been no sales of wet mechanical pulp.

Legal Notes

BY WELLINGTON GUSTIN

Failure to Give Notice of Defects Under Provision of Contract Constitutes Acceptance

From Georgia comes an action at law brought by the York Manufacturing Co. against the South Atlantic Packing & Provision Co. to recover the price of certain ice-producing machinery installed for it under written contract. The machinery was to be affixed to and used with certain other machinery of the defendant, for the purpose of connecting a distilled-water ice plant into a raw-water ice plant. The contract contained necessary specifications and two guaranties were included as follows:

(1) That the plant when changed as specified will be capable of producing 100 tons of merchantable raw-water ice per day of 24 hours when in full and continuous operation according to instructions.

(2) That the coal consumption of this plant when producing 100 tons of ice per 24 hours would be not less than a ratio of 16 tons of ice per ton of 14,000 B.t.u. coal burned, based on the guaranteed boiler evaporation of 9 lb. of water per pound of coal with steam at 185 lb. and 160 deg. superheat at boiler.

The guaranty of quality of ice was based on water being taken from well known as No. 3, which had been tested.

PLAINTIFF AGREED TO REMEDY DEFECTS IF NOTIFIED WITHIN 30 DAYS

The contract also provided that when plant was ready for charging written notice should be furnished to defendant of that fact and that if for a period of 30 days thereafter the defendant should fail to notify plaintiff in writing of any claim that the said machinery, apparatus or plant as furnished did not fulfill the terms and requirements of the contract, this fact would be taken as an acknowledgment by the purchaser that they did fulfill all requirements and should constitute a complete acceptance of the same as fulfilling all the terms and requirements of the contract. If such notice of failure was given within 30 days, the plaintiff was to remedy any such defects.

DEFENDANT FAILED TO GIVE NOTICE WITHIN SPECIFIED TIME

It appears that no objections to the plant as completed were given within 30 days thereafter. Yet defendant pleaded in answer to the suit that the plant failed to produce 16 tons of ice to 1 ton of coal, 14,000 B.t.u., and that the plant failed to produce 100 tons of merchantable ice in 24 hours' continuous operation.

The District Court excluded all testimony offered to show that the plant did not comply in all respects with the contract and did not fulfill its terms and requirements, on the ground that defendant, having failed to give notice of such defects and failures within 30 days after receiving notice that the plant was erected ready to charge, had under the terms of the contract accepted said plant as fully complying with said contract and its guaranties and could not thereafter make such denial.

The United States Circuit Court of Appeals (276 Fed.

eral, 509) has upheld the District Court on this point, holding the 30-day provision valid and enforceable; and a failure to give such notice within 30 days after completion of plant was held a complete acceptance of said plant, precluding defendant from claiming breach of a warranty that plant would produce a stated quantity of ice per ton of coal consumed.

Contracts Requiring Return of Acetylene Containers Held Not in Restraint of Trade

Contracts under which tanks are furnished to purchasers of acetylene gas to be returned and refilled exclusively by the original manufacturer are not unconscionable nor in restraint of trade, in violation of the Clayton act of Oct. 15, 1914, section 3 (Comp. St., par. 8835c), says the United States Circuit Court of Appeals, affirming a decree of the District Court in favor of the Prest-O-Lite Co. in a suit in equity against the Auto Acetylene Co. (276 Fed., 537.)

The Prest-O-Lite Co. has for many years been engaged in generating, storing and distributing acetylene gas for use in automobile lighting and in welding. Its gas is stored in portable steel cylinders lined with asbestos or other porous material, which absorbs a quantity of acetone, which, in turn, is saturated with acetylene gas introduced under pressure, the outflow for consumption being valve controlled. The entire package so filled is furnished the consumer in the first instance. When the tank is consumed, the tank is accepted in exchange for a package fully charged by the company. It appears that this company has had much litigation in protecting itself and its product against unfair competition.

CONTRACTS WITH WELDING TRADE

In 1913 the company extended its service to the welding trade, under a system generally similar to that relating to automobile lighting, but differing therefrom in the fact that its welding tanks are supplied to its customers under contracts which treat the tanks as held by the customer as containers merely of its gas, and on rental only, each tank bearing on the outer surface permanent legends, including the serial number of the cylinder, the date of manufacture, its weight and the fact that it is plaintiff's property, together with the statement that the acetylene is prepared and pressed into porous substance in compliance with certain governmental specifications, and that, when empty, it is to be redelivered to plaintiff.

DEFENDANT REFILLED PLAINTIFF'S TANKS

The defendant, Auto Acetylene Co., is engaged in manufacturing and selling acetylene gas in tanks similar to those of plaintiff. Now the complainant alleged defendant's knowledge of plaintiff's rights, including its contracts and exchange service, and charged that defendant induced, procured and assisted plaintiff's customers in violating their contracts with plaintiff, by refilling tanks with defendant's gas, etc. An injunction was asked against such acts of defendant.

Defendant answered alleging that plaintiff's contracts with its customers amounted really to sales, that the consumers believed that they were purchasing the tanks and that such contracts violate the Clayton anti-trust act. Further, the defendant sought affirmative relief asking that plaintiff be enjoined from representing to

its customers that it is the owner of the tanks, and from seeking to prevent such consumers from having their tanks refilled by defendant.

DEFENDANT ENJOINED FROM INTERFERING

The final decree in the case enjoined the defendant from interfering with plaintiff's system of exchange and from causing such welding service contracts to be violated, and procuring the delivery of plaintiff's exhausted tanks to any one other than plaintiff for refilling or otherwise, from receiving or refilling such tanks or damaging the same, and from dealing in or exchanging such welding tanks.

PLAINTIFF RETAINED TITLE TO TANKS

The court found that plaintiff by its contracts with customers retained title to the tanks, the contracts providing that complainant shall keep filled tanks in reserve and exchange them for empty tanks when returned without charge, except for the contents, and did not pass title in tanks. And the refilling by defendant of the tanks furnished by plaintiff to its customers for their use, but which remained its property, and in so doing knowingly assisted and encouraged customers to violate their contracts under which the tanks were furnished, was such a violation of plaintiff's rights as to entitle it to an injunction.

The important question presented was whether the contract between plaintiff and its customers violated the Clayton act, which makes it unlawful to lease "goods, wares, merchandise, machinery, supplies or other commodities" on the condition, agreement or understanding that the lessee shall not use the supplies of a competitor of the lessor, where the effect of such lease or condition, agreement or understanding may be "to substantially lessen competition or tend to create a monopoly."

If the transaction were an absolute sale of the tank (and the court found it was not), any restriction whatever upon its use would be void, independently of the Clayton act. The contract in substance forbids the customer to use in the tank any gas except that manufactured and packed by plaintiff.

TANKS NOT LEASED

Regarding the charged violation of the Clayton act two questions were presented to the court. One was whether the contract effects a lease of a tank, and the other was whether the refilling of the tanks with gas amounts to using or dealing in "supplies" within the meaning of the act. These were answered in the negative by the court. No given tank was leased, for under the contract any tank, of one class or the other, is in the first instance delivered to the customer. This tank is to be returned when empty. The same tank is not then returned to the customer, and may never be, but another tank of the same class is returned, refilled, and so on to the end of the service. The customer has no interest in any particular tank, except while filled and in his possession, and then only because it is the container of the gas.

It was found that the Mimeograph case, 32 Sup. Ct., 364, relating to supplies, did not apply here. The court says it is more proper to say that the delivery of the storage tank as a package or container is merely incidental to the furnishing of the gas than that the former is the subject of a lease and the latter a supply for a leased package. Acetylene gas cannot be bought, sold

or delivered in the market in the way that ordinary merchandise and "supplies" are sold and delivered; but it can be delivered only by filling the package with gas compressed therein—a circumstance which differentiates it from supplies as the term is ordinarily used.

NO PRECEDENT TO GUIDE COURT

This case presents a new point and no precedent could be found to guide the court.

As to the charge that the contracts in question substantially or unreasonably lessen competition or tend to create a monopoly, it was shown there was no agreement between competing companies, through division of trade or regarding price, and the records showed a highly active competition between plaintiff and defendant, unless in the bare fact that the customer under contract with plaintiff is more apt, other things being equal, to obtain its gas from plaintiff than from a competitor. In this relation this case bears some analogy, said the court, to the so-called pump and tank cases, where it was held that a requirement that dealers distribute only the loaner's product from leased devices is not an unfair method of competition, nor does it substantially lessen competition.

Belgian Artificial Silk Industry Approaching Pre-War Condition

The Belgian artificial silk industry, which before the war produced about one-quarter of the world's supply, has recently shown unmistakable signs of improvement, and the largest of the four mills in Belgium reports that present demand exceeds production. Production before the war averaged 2,700,000 kilos. Of the four largest plants which survived the war, only one was able to resume manufacturing in July, 1919, but the other mills followed at short intervals, so that by the end of 1920 the industry had resumed about 70 per cent of its pre-war status.

Only 5 per cent of the total production was consumed at home in 1914. Half of the total production went to Germany, whence many of the raw materials and chemicals were obtained. In recent years, however, exports of artificial-silk yarn have gone largely to the United Kingdom and Switzerland. The latter country, as may be seen from the following table, took 111,000 kilos out of a total export of 153,000 kilos exported by Belgium in 1921:

BELGIAN IMPORTS AND EXPORTS OF WASTE-SILK YARN AND ARTIFICIAL-SILK YARN

Countries	Imports			Exports		
	1920 Kilos	1921 Kilos	January- March, 1922 Kilos	1920 Kilos	1921 Kilos	January- March, 1922 Kilos
Germany.....	293	1,127	161	9,028	1,307	....
Spain.....	....	....	....	1,504	600	....
France.....	2,882	1,419	354	....	1,874	3,517
United Kingdom.....	1,441	1,133	252	7,856	29,451	6,032
Switzerland.....	1,357	1,047	153	5,278	111,463	92
Other.....	47	1	....	4,696	8,002	399
Total.....	6,020	4,727	920	28,362	152,697	9,980

Statistics concerning manufactures containing artificial silk can not be identified in trade figures. Shipments to the United States, which for a time had fallen off considerably, have of late been resumed, as some large American orders were placed with Belgian mills. A brisk demand is also reported from Spain, Portugal, Switzerland and Japan, but despite the present activity one large manufacturer is pessimistic as to the future of artificial silk manufacture in Belgium because of tariff restrictions.

Effect of Temperature, Pressure and Structure on Mechanical Properties of Metal

BY ZAY JEFFRIES AND R. S. ARCHER

IN A previous paper entitled "Mechanical Properties of Commercial Iron" (*Chem. & Met. Eng.*, vol. 27, p. 694, Oct. 4, 1922) the art of testing metals was discussed in a general way, and some indication given as to how the various circumstances surrounding the test—such as size of specimen or rate of loading—affect the results obtained. Given the fact that such extraneous conditions have been standardized and are under close control, three principal variables affect the properties of metal: temperature, pressure and structure. We shall have most to say on the third of these factors.

TEMPERATURE SCALE

The recrystallization temperature constitutes a point of division in the temperature scale of a metal: at higher temperatures the metal is "hot" and at lower temperatures "cold." Deformation at 250 deg. C. is hot working for lead or zinc but cold working for iron or nickel. When the various ductile metals are compared at a fixed temperature, such as the ordinary atmospheric temperature, they are found to be widely different in mechanical properties, but if the comparison is made at temperatures similarly related to the respective recrystallization temperatures, the metals are found to be not so unlike.

Below the temperature of recrystallization the structure of a metal is relatively permanent. Any change produced by deformation prior to a mechanical test or by the deformation incident to the test itself is cumulative. Above the recrystallization temperature, on the contrary, the internal structure is constantly subject to grain growth which largely wipes out the effects of deformation. Material at grain boundaries also possesses a capacity for viscous flow under stress much greater than at lower temperatures. The phenomena encountered in the two temperature ranges therefore fall naturally into different classes.

There is another fairly marked but not very definite point in the temperature scale of a metal. It is the temperature at which the metal becomes brittle on cooling. Iron in the annealed condition is ductile at room temperature but brittle in liquid air (—185 deg. C.) unless very fine grained. Equiaxed tungsten wire is ductile at 200 deg. C. but brittle at room temperature. Annealed copper, however, is ductile at the lowest temperatures at which it has been tested. In general the temperature at which brittleness appears on cooling is highly dependent on the structure of the metal. This brittleness is often accompanied by low or erratic strength, due to the easy development of high local stresses by eccentric loading. It follows that values for strength are likely to be most dependable when the temperature of test is such that there is appreciable ductility.

The temperature scale of a solid metal can thus be roughly divided into three regions: (1) A region of low-temperature brittleness. For most metals this is below ordinary atmospheric temperatures. (2) An inter-

Recrystallization, Annealing, Cold-Work and Inclusions Have Profound Effect on Size and Shape of Crystalline Grains and Therefore on Properties of Metal—A Study of the Mechanical Properties of Single Crystals

mediate region above the temperature at which the metal becomes brittle due to cold, but below the temperature of recrystallization. It is in this temperature region that most metals are used. Mechanical working in this zone is called "cold-working" and causes an increase in hardness and decrease in plasticity. (3) A zone of hot-working, lying above the temperature of recrystallization. Metals possess little elasticity at these temperatures, but flow slowly under small loads. In this zone mechanical working can be carried on to a practically unlimited extent.

The strength and hardness of metals normally decrease on raising the temperature, while the plasticity increases. Fig. 1 shows the effect of temperature on the tensile strength, elongation and reduction of area of copper. The elongation was measured on a gage length equal to eighty times the diameter of the specimen, so the values represent general elongation practically unaffected by the local stretch at the fracture. The results obtained at the higher temperatures depend largely on the rate of loading. The tests from which these curves are plotted were made in from 2 to 10 minutes.

Tensile strength decreases continuously from —185 deg. C. to 950 deg. C., and is known to continue decreasing to the melting point (1,084 deg. C.).

Elongation also decreases continuously from —185 deg. C. to the melting point. Throughout the same temperature range the plasticity increases, but elongation depends on both plasticity and strength; the decrease in elongation with rising temperature is due to the large decrease in tensile strength. Since the elongation has its highest value at the lowest temperature shown, it is obvious that the entire curve lies within the last two of the temperature regions mentioned above—i.e., the intermediate and the high. Copper probably enters the low-temperature zone of brittleness some-

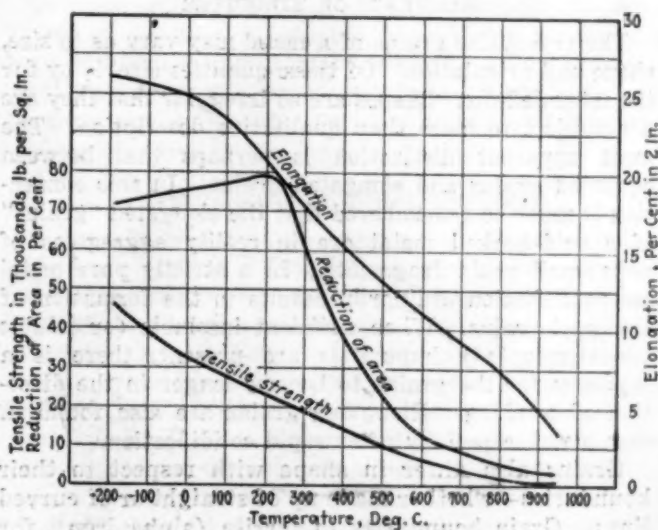


FIG. 1—EFFECT OF TEMPERATURE ON TENSILE PROPERTIES OF ANNEALED COPPER WIRE

where between -185°C . and absolute zero, but no actual tests are known to the authors.

Reduction of area increases slightly with rising temperature up to the temperature of recrystallization, above which it falls off sharply.

Tensile strength, elongation and reduction of area are all increased to a marked extent by increasing the rate of loading when testing above the recrystallization temperature.

Fig. 2 shows the effect of temperature on the elongation of annealed molybdenum. In these curves the low and intermediate temperature zones are represented. Recrystallization occurs at about 900°C ., the highest temperature at which these tests were carried out. It is to be noted that the fine-grained wire retained its ductility at lower temperatures than the others.

PRESSURE

Metals are perfectly elastic under pressure applied uniformly on all sides (under hydrostatic pressure). They are compressed as the pressure is applied, but on removal of the pressure regain their original volume except for the closing up of cavities. There is no permanent change in structure or properties. Hydrostatic pressure does not cause plastic deformation or cold-working effects.

Hardness increases with pressure, especially for soft materials. When a metal is under great hydrostatic pressure its resistance to deformation is greater than at low pressures.

Metals are seldom used under hydrostatic pressures of any important magnitude, but such pressures are encountered in some fabricating processes. Extrusion is probably the best example. The metal is confined in a receiver, usually of cylindrical form, and pressed out through a die by a ram. Pressure is exerted on the metal on all sides except at the opening through which it is extruded. When a metal is worked in confined dies, as in swaging, and to a less extent in pressing and forging, it is under hydrostatic pressure, although there are of course other forces which cause the desired deformations. Hydrostatic pressure acting on the metal in these fabricating processes contributes to its plasticity by holding the crystalline fragments in more intimate contact during deformation.

ELEMENTS OF STRUCTURE

The crystalline grains of a metal may vary as to size, shape and orientation. Of these qualities size¹ is by far the most definite. Shapes are so irregular that they are not subject to more than qualitative description. The most apparent distinction is perhaps that between equiaxed grains and elongated grains. In this connection it must be remembered that the elongated "grains" of a cold-worked metal are in reality aggregates of very small grain fragments. In a strictly pure metal recrystallization ordinarily results in the formation of equiaxed grains. When sufficient insoluble (or soluble but segregated) impurities are present, there is a tendency for the grains to become longer in the direction of working. Elongated grains are also found in cast metal, especially after rapid solidification.

Grains also differ in shape with respect to their boundaries—whether made up of straight or of curved lines. Grain boundaries in ferrite (alpha iron), for

¹Methods of measuring and expressing grain size are described in an article on Grain Growth, *Chem. & Met. Eng.*, Feb. 22, 1922, p. 343.

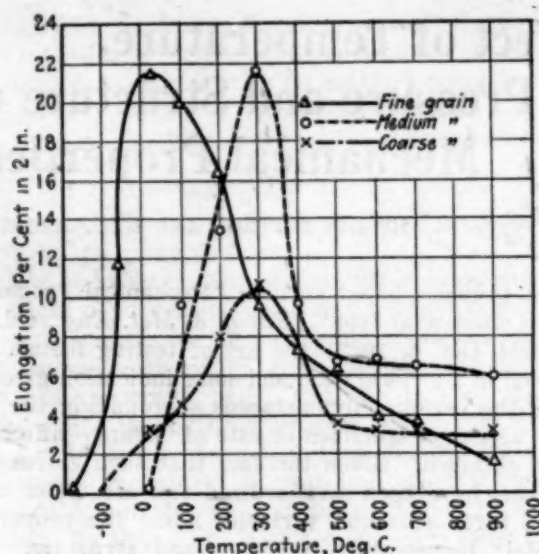


FIG. 2—EFFECT OF TEMPERATURE ON ELONGATION OF ANNEALED MOLYBDENUM WIRE (SYKES)

example, are normally quite curved and irregular, although they tend to become more rectilinear after certain annealing treatments. In gamma iron and the austenitic solid solutions formed from it the grain boundaries are as a rule straight and regular.

To describe the structure of a metal with reference to the orientation of its grains is still more indefinite. To begin with, it is quite difficult or at least tedious to determine the orientation of any particular grain. It seems that ordinarily the grains possess fairly well-mixed orientations. X-ray diffraction patterns show, however, that in some cold-worked metals there is a tendency for the crystal fragments to assume a certain uniformity of orientation, which is found to persist to some extent after annealing. There is a peculiar type of "rectangular" brittleness sometimes encountered in annealed mild steel sheet which is attributed by Stead² to a more or less uniform orientation of the grains.

Fine grain is generally held to be a desirable structure, promoting toughness, strength and ductility. Strength and hardness increase as grain size decreases, at least in the intermediate temperature zone. At high temperatures fine grain is a source of softness, especially under prolonged application of load which leads to flow at the grain boundaries. In general, small grain size contributes to hardness under conditions of temperature and rate of loading which lead to deformation by slip.

Plasticity decreases with grain size, in the sense that more effort is required to bring about a given deformation and that the strain hardening effect of a given deformation increases. Malleability often increases as the grain size becomes smaller, however, because of the increased strength. Fine-grained zinc, for example, is malleable at ordinary temperatures, whereas coarse-grained zinc is brittle. Maximum ductility usually occurs at an intermediate grain size. Alpha brass, nickel, silver and copper show maximum elongation at room temperature after an anneal well above the lowest recrystallization temperature, but well below the melting point, and hence with medium grain size. The reduction of area seems to be greater

²"Brittleness Produced in Soft Steel by Annealing," J. E. Stead, *J. Iron & Steel Inst.*, 1898, No. 11, pp. 137-184.

the finer the grain, within the limits of our ability to produce fine-grained recrystallized structures. There must be a limit to the reduction in grain size beyond which further refinement of grain will produce less reduction of area.

DEFORMATION

It is now known that cold deformation produces refinement of grain in the sense that one original grain, after severe cold-work, exhibits a mixture of orientations.⁸ This type of grain refinement is not the same as the refinement of grain produced by annealing at low temperatures. For example, a metal may be obtained with the same hardness by moderately cold-working a coarse-grained piece or by annealing a severely worked piece at a temperature which will produce small unstrained grains. Although the hardnesses are the same, the other properties may not be and usually are not the same. These and other considerations make it necessary to consider that cold-working produces a structure unlike that obtained in any other manner. Even though there is refinement of grain by cold-working, the directional properties of the crystals are never obliterated, and in fact it seems that the extreme conditions of cold-work actually favor additional directional characteristics, such as a tendency for the crystal units to be oriented in a certain manner with reference to the direction of deformation. This condition has been described by Berger⁹ in very fine tungsten wire.

Inasmuch as the structures produced by cold deformation are unique and are too minute for direct observation, the structural condition of cold-worked metals must be described in terms of the deformations to which they have been subjected.

The general effect of cold deformation is to increase hardness and decrease plasticity. The yield point and tensile strength are increased, and the elongation and reduction of area are decreased. The capacity for further cold-work is of course decreased. Annealing above the recrystallization temperature removes the hardening effects. Fig. 3 shows the effect of progressive cold-rolling on the properties of a very pure grade of copper. After being reduced cold 50 per cent in section, the metal was annealed at various temperatures, with the results shown on the right-hand side of the diagram.

⁸"Mixed Orientation Developed in Crystals of Ductile Metals by Plastic Deformations," by E. C. Bain and Zay Jeffries. *Chem. & Met. Eng.*, vol. 25, p. 775, Oct. 26, 1921.

⁹Communication from laboratories of N. V. Phillips Lamp Factory, Eindhoven, Holland, September, 1921.

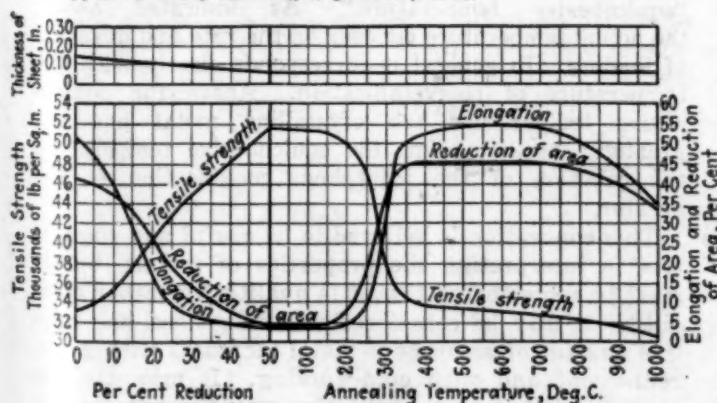


FIG. 3—EFFECT OF COLD-ROLLING AND ANNEALING ON PROPERTIES OF COPPER (MATHEWSON AND THALHEIMER)

In general the effects of hot-working are very much the same as those of cold-working followed by annealing above the recrystallization temperature. Although at high temperatures metals are capable of some permanent deformation by the process of viscous flow at the grain boundaries and perhaps migration of the boundaries themselves, most of the deformation incident to hot-working takes place by the breaking up of the crystals and the movement of the fragments along the slip planes. This type of deformation produces conditions favorable to grain growth. Immediately after a deforming operation, such as a hammer blow or a pass through rolls, grain growth takes place in accordance with the temperature until interrupted by the next deformation, which again breaks up the grains. The final grain size of hot-worked metal therefore depends largely upon the finishing temperature. A very high finishing temperature is apt to result in excessively coarse-grained metal. If, on the other hand, working is continued until the metal has cooled down around the recrystallization temperature, a somewhat strain-hardened condition may obtain.

Hot-working creates "fiber." Physical defects in a cast metal such as blow holes, pipes, slag or oxide films are drawn out in the direction of working. The non-metallic impurities, being often brittle at the working temperature, are also to a large extent broken up and scattered. The result is a general improvement because of the greater continuity of the metal, and a special improvement in the direction of the working. The distribution of the impurities is such that their total cross-section on planes perpendicular to the direction of working is much less than on planes parallel to the direction of working. This may lead to quite appreciably lower physical properties—particularly elongation and reduction of area—in test-bars taken at right angles to the direction of working, or "across the grain" of the metal. This effect is of course more marked the greater the amount of impurities present.

Impurities also affect the shapes of the grains. A perfectly pure and physically sound metal would, after hot-working, not only have the same properties in all directions, but would have equiaxed grains. Non-metallic impurities generally obstruct grain growth, and because of their distribution in worked metals, the obstruction to growth at right angles to the direction of working is greater than the obstruction to growth in the direction of working. The grains of hot-worked metals, or of metals that have been cold-worked and annealed, therefore tend to be elongated in the direction of working.

PROPERTIES OF METAL CRYSTALS

A single crystal is an aggregation of atoms occupying (or vibrating about) definite equilibrium positions to which they tend to return if displaced by the application of an external force. This gives rise to the property of elasticity. The mathematical exactness of the space lattice results in a perfection of elasticity not attained in non-crystalline bodies. It may follow that single crystals are perfectly elastic. Any deformation short of rupture produced by an external force disappears on removal of the force. Furthermore the extent of the deformation remains constant under a constant force—that is, there is no flow in a single crystal. The rate of application and the dura-

tion of load; therefore, are of little significance, and return to the initial form on removal of load takes place very quickly with none of that "creep" shown by amorphous solids.

Failure of crystals under load seems always to take place on crystallographic planes, which are to be recognized as planes of weakness. If the fragments adhere to each other, the crystal is said to be plastic, and the planes of failure are slip planes or gliding planes. If the fragments do not adhere, the crystal is brittle and the planes are called cleavage planes. In either case failure takes place by a shearing action, and the first failure marks the end of the single crystal. Up to this point the crystal is elastic. Therefore the only "strength-property" of a single crystal is its elastic limit in shear, which is of course different in different crystallographic directions. Hardness depends on the same property, since any method of hardness testing involves failure by shear. Conversely, we may regard the "strength" of single crystals, whether of pure metals or of metallic compounds, as approximately proportional to their hardness.

Crystallization of a metal from the molten state is accompanied by the sudden development of a definite shearing strength. This strength increases as the temperature falls in a manner which, so far as we know, is continuous, unless there is an allotropic change. The strength of a crystal is evidently due to the attractive forces between its atoms. Thermal vibrations of the atoms oppose these attractive forces so that at high temperatures the crystals are relatively soft and weak. As the temperature falls the amplitude of atomic vibration decreases and the interatomic forces become more and more assertive, increasing the hardness and strength. Since the damping of atomic vibration is a continuous function of the temperature, the increase in strength of a single crystal on cooling must also be continuous, as long as there is no change in the arrangement of the atoms—that is, no allotropic change. The modulus of elasticity also increases continuously on cooling.

The properties of crystals of the various metals depend on the characteristics of the atoms of which they are built and on the type of space lattice in which the atoms are arranged. Only three types of lattice, all simple, have been found in most metals. These are the face-centered cubic, body-centered cubic (or centered cubic), and hexagonal close-packed. All metals known to crystallize with the face-centered cubic arrangement are ductile throughout a wide range of temperature. Examples of this class are gold, silver, copper and aluminum. The hexagonal arrangement appears less conducive to ductility, as illustrated by the metals zinc, cadmium and magnesium. Hull has pointed out that in the hexagonal arrangement there is only one set of planes parallel to which easy gliding or slip can take place, whereas in the face-centered cubic there are four. Both ductile and brittle metals are found with the body-centered cubic arrangement, which seems somewhat less favorable to ductility than the face-centered.

AMORPHOUS METAL

There must of necessity be some disorganization of the crystalline structure at the grain boundaries of metals and on most of the surfaces of slip. The degree of disorganization probably varies all the way from perfect crystallinity to the completely disorgan-

ized structure denoted by the term "vitreous amorphous." All such metal of disorganized structure simulates the vitreous amorphous materials in its mechanical properties.

Fluidity is the important characteristic of amorphous materials. Plastic deformation takes place by the same kind of flow as in ordinary liquids, except that at low temperatures the viscosity is very great. Whereas the strength of a crystal depends on temperature and is practically unaffected by the duration of loading, the resistance to deformation of an amorphous material not only

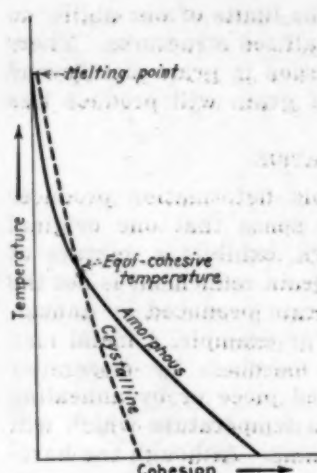


FIG. 4—COHESION-TEMPERATURE RELATIONS OF AMORPHOUS AND CRYSTALLINE METAL

varies rapidly with the temperature for a given rate or duration of loading, but if the temperature is constant depends entirely on the rate and duration of loading.

In Fig. 4 are two curves representing qualitatively the effect of temperature on the "cohesion" of crystalline and amorphous metal. For this purpose cohesion of crystalline metal denotes the stress required to cause failure by slip. That is, cohesion is measured by the elastic limit of the crystal. Cohesion of amorphous metal is also measured by the elastic limit—i.e., the maximum stress that can be sustained without permanent deformation. This quantity obviously depends on the time during which the stress acts. The curve therefore represents only one rate and duration of loading.

It will be noted that the crystalline metal is represented as acquiring a definite cohesion at the time of its formation—that is, at the freezing point of the metal—but there is no discontinuity in the cohesion of the amorphous metal at this point. Below the freezing point the cohesion of each modification increases continuously as the temperature falls, the rate of change being most rapid in the case of the amorphous metal. At some temperature the curves intersect, indicating that the cohesion of the amorphous modification has become equal to that of the crystalline. This temperature has been called the "equicohesive temperature." As indicated above, the actual temperature depends on the rate and duration of loading. In general it corresponds closely with the temperature of recrystallization. Above the equicohesive temperature the crystalline metal has the greater cohesion; below the equicohesive temperature the cohesion of the amorphous modification is the greater.

This conception is believed to be useful and suggestive in interpreting the properties of metals, but it must be remembered that it is qualitative rather than exact. It may be considered that in general the relative amount of amorphous metal increases with grain refinement and with cold-working. It may also be considered that in a qualitative way the greater the amount of the amorphous modification present the more do the properties of a metal tend toward those of a vitreous amorphous material. For example, the

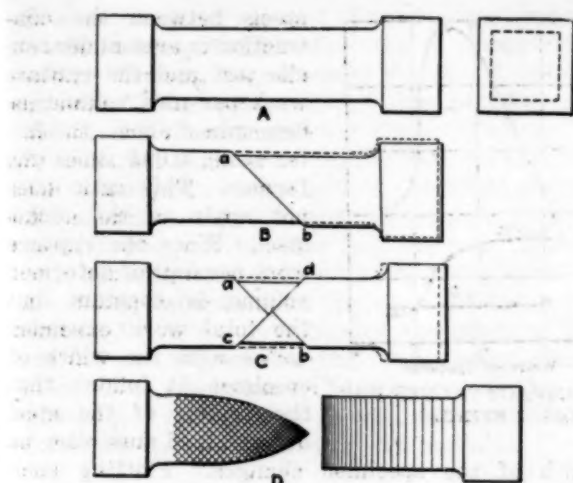


FIG. 5—PLASTIC DEFORMATION OF TEST-BAR COMPOSED OF SINGLE DUCTILE CRYSTAL

property which metals have at high temperatures of yielding slowly under constant load is presumably due (at least in part) to the viscous flow of the disorganized metal at the grain boundaries. Since the amount of this disorganized or amorphous metal is greater in a fine-grained metal than in a coarse-grained metal, we should expect the fine-grained metal to be softer at high temperatures and harder at low.

TENSILE TESTS OF SINGLE CRYSTALS

Sykes⁸ has described some very interesting tests of molybdenum wire in which many of the grains extended completely across the diameter of the wire (0.025 in.). At 200 deg. C. and lower temperatures the path of rupture followed the grain boundaries. At 300 deg. C. and up to 900, which is approximately the recrystallization temperature of molybdenum, the fracture was decidedly transcrystalline. In this temperature range, the wire drew down to a wedge at the fracture. The reduction of area was practically 100 per cent, but in one direction the diameter of the wire was scarcely reduced at all. This means that the deformation has been confined chiefly to two sets of slip planes.

The mechanism of deformation of a single crystal is illustrated schematically in Fig. 5, wherein A represents a test-bar of square cross-section consisting entirely of a single grain of a ductile metal. It is further supposed that this grain has such an orientation that planes of easy slip are perpendicular to the plane of the paper and make angles of about 45 deg. with the axis of the test-piece. Now if the piece is subjected to tension, shearing stresses are developed which reach a maximum value at 45 deg. to the tensile load and hence parallel to the planes of easy slip. As these stresses increase, failure of the crystal will take place in the form of slip, or block movement, along one of these planes, *ab*, the location of which will generally be determined by some local weakness. (Fig. 5-B.)

Ductile metals possess the property of automatically limiting the extent of the movement on any particular slip plane. Instead of slip continuing on the first plane until complete rupture of the piece occurs, the movement comes to a stop after a displacement which is very small as compared with the dimen-

sions of the test-piece. Resistance to movement along the first slip plane increases; further slip is forced to take place on new planes.

Let us suppose that the second slip is on a conjugate plane *cd*, making an angle of about 90 deg. with the planes of the first set. (Fig. 5-C.) It is readily seen how repeated slips of this character result in a general increase in the length of the test-bar and a decrease in its diameter.

Fig. 5-D represents the test-bar after rupture. The view on the left shows the same surface of the bar as in the three views above, and illustrates the multiplication of intersecting slip planes, especially near the fracture. The view on the right shows a face of the test-bar at 90 deg. to that on the left. It will be noted that there has been no reduction in diameter on this face at the fracture. The test-piece has drawn out into the shape of a wedge.

A remarkable study of single crystals of aluminum has been reported by Carpenter and Elam.⁹ These investigators worked with flat test specimens 1x0.125 in. and with round specimens having diameters of 0.564 and 0.798 in. With each type of specimen they succeeded in converting the entire parallel portion into a single crystal.

The bars of circular cross-section in which a single crystal occupied the entire cross-section drew out into the form of wedges, as did Sykes' wires. Because of the much larger size of the aluminum bars, the edge of the wedge was not actually sharp, but retained a well-defined lens shape at the fracture. Reduction in diameter in the other direction was very slight.

Flat single-grain test specimens of aluminum assumed forms during deformation and fracture which varied widely with the orientations of the grains, as would be expected. In one type the specimen became narrower, but retained practically its full thickness, while in a second type the specimen became thin, but retained substantially its original width. All bars were characterized by the small number of the systems of slip planes on which movement took place, and by a uniformity of direction of slip in any one grain.

Acetone as a Solvent for Mineral and Rosin Oils

In the course of an investigation being conducted at the Mellon Institute of Industrial Research of the University of Pittsburgh regarding the solvent properties of acetone on various commercial products, a number of mineral lubricating oils were tested. From the data thus obtained it has been concluded that acetone does not possess high solvent power for such oils. It was noted that the solvent power of acetone decreased as the viscosity of the mineral oils increased. Acetone is miscible in all proportions with gasoline and kerosene and possesses the least solvent action on the paraffin, from which it has been concluded that it is a better solvent for the lower molecular weight hydrocarbons.

Acetone has been used to remove paraffin wax from shale oil and lignite tar. Claim has also been made for its use in removing tarry matter from light lubricating oils, thus increasing their suitability for cylinder lubrication.

The grade of acetone used in these tests was obtained by the destructive distillation of calcium acetate and was of excellent purity and uniformity.

⁸"Effect of Temperature, Deformation, Grain Size and Rate of Loading on the Mechanical Properties of Metals," W. P. Sykes, *Trans., A.I.M.E.*, vol. 60, p. 780.

⁹"The Production of Single Crystals of Aluminum and their Tensile Properties," H. C. H. Carpenter and C. F. Elam. *Proceedings of the Royal Society, A*, vol. 100, 1921. Abstracted in *Chem. & Met. Eng.*, vol. 26, p. 514, March 15, 1922.

Deformation of Material by Impact Test

IT HAS BEEN frequently stated that anomalies in impact testing have been due to variations in the dimensions of the test-piece and to the habit of expressing the result in energy of rupture per square inch of fractured area. M. Moser of Krupp's laboratory recently tested¹ the theoretical conclusion that if the total energy of rupture were divided by the volume of deformed steel, the result would be independent of the size of the bar. His colleague, Dr. Fry, determined the volume of overstrained metal by the latter's new etching method.

Standard German impact pieces are 3 cm. square notched by saw cut terminating in a drilled hole 4 mm. in diameter; the surface to be broken is 1.5 cm. deep and 3 cm. wide. Moser tested four steels (Table I) by varying the width of the specimen from 0.5 to 3 cm.

TABLE I—STEELS USED IN THE RESEARCH

	Analysis					Principal Properties			
	C	Si	Mn	Ni		Elastic Limit	Ultimate	Elongation	Contraction
Carbon steel A	0.70	0.24	0.52	...		57,000	112,000	12.2	18.0
Carbon steel B	0.43	0.16	0.36	...		43,000	71,500	30.5	51.0
Carbon steel C	0.35	0.29	0.61	...		49,800	78,300	30.3	56.4
Nickel steel D	0.12	0.05	0.35	4.85		60,200	73,900	32.5	70.8

His machine was of the Charpy type, its pendulum weighing 66.1 kg., falling 2.868 m. from an angle of 80 deg., and striking the piece with an energy of 189.6 kg.-m. Results are shown graphically in Figs. 1 to 4 inclusive. Except for the nickel steel, the energy of rupture departs widely from proportionality. Likewise, that steel only has a constant value for energy of rupture per unit area. However, when the energy of rupture is divided by the volume of overstrained metal, the value is constant and independent of the width of specimen, yet quite different for the materials. Numerical results follow:

Steel	Rupture Work Per Unit Volume
0.70 Carbon steel A.....	1.9
0.43 Carbon steel B.....	4.8
0.35 Carbon steel C.....	5.3
4.85 Nickel steel D.....	11.6

As before noted, Dr. Fry examined the broken specimens by preparing polished cross-sections at various points and etching them by his newly developed methods. In this way the boundaries of the deformed material were determined and the volume of this material could be calculated.

A further striking relationship exists for the carbon

¹Stahl und Eisen, 1922, vol. 42, p. 90.

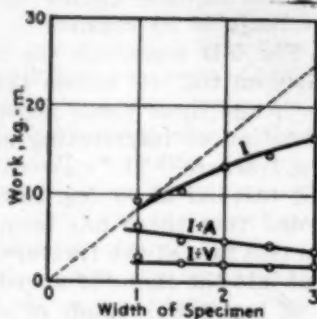


FIG. 1—IMPACT VALUES FOR 0.70 C STEEL

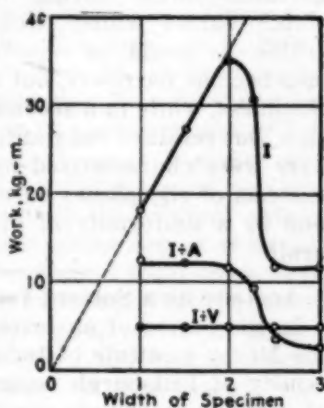


FIG. 2—IMPACT VALUES FOR 0.43 C STEEL

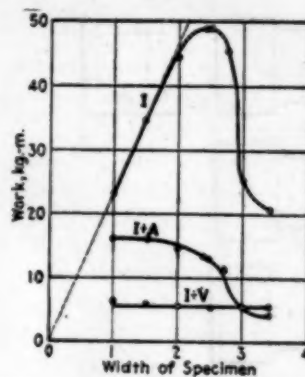


FIG. 3—IMPACT VALUES FOR 0.35 C STEEL

steels between the contraction in area under tensile test and the rupture work per unit volume, as determined above, the latter being 0.094 times the former. This ratio does not apply to the nickel steel. Since the rupture work per unit of deformed volume is constant but the total work expended varies with the width of specimen, it follows that the volume of the steel overstrained must vary as the width of the specimen changes. Plotting such volume against width, we get four curves of the same shape as the respective curves for total work in Figs. 1 to 4. Each of the curves is tangent at its lower end to a line passing through the origin. The carbon steels deflect from this line when the width of specimen exceeds 2.0 cm., but the nickel steel holds to the line for widths as high as 3.0 cm. Strangely enough, the slope of the line is identical for all four steels. This seems to indicate that the amount of material deformed when breaking a test specimen notched according to the German standard depends only upon the width of the specimen. That is to say, the metal is deformed on the average 1.4 cm. deep on either side of the fracture, for specimens shaped as described

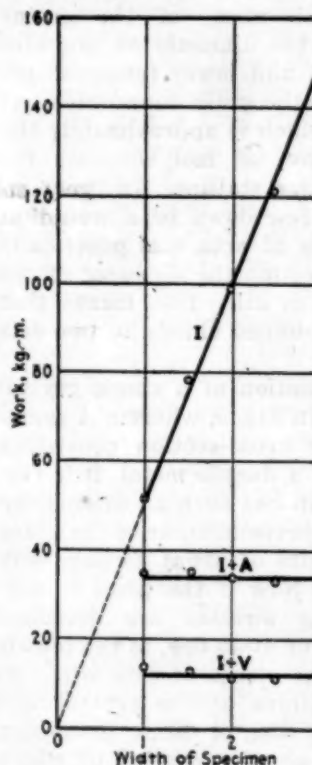


FIG. 4—IMPACT VALUES FOR 4.85 NI STEEL

and up to 2.0 cm. wide, despite the strength of the material. Figures for total work of rupture for such specimens should therefore give comparative figures; i.e., stand in the same relationship as the work per unit volume of overstrained metal².

Since the energy of the falling hammer is far greater than that necessary to break the weaker steels, the height of fall was reduced to 1 m., just sufficient to break the 3.0-cm. test-piece of steel B. Testing pieces of different width with this milder impact, a series of curves similar in form to Fig. 4 were obtained, showing that under these circumstances the energy of rupture is now proportional throughout to the width of the specimen. The energy of rupture ex-

²The following tabulation gives numerical results as determined from experiment, and from these an idea may be had on the correctness of the generalization.

VOLUME OF DEFORMED METAL

	Specimen		
	1.0 Cm. Wide	1.5 Cm. Wide	2.0 Cm. Wide
Steel A.....	4.0	5.5	6.8
Steel B.....	3.8	5.7	7.3
Steel C.....	4.2	6.5	8.3
Steel D.....	4.0	6.3	8.7
Approximation from rule.....	4.2	6.3	8.4

pressed in energy per unit of area or per unit of volume has become a straight line and a linear relationship exists between the deformed volume of metal and the width. The specimen is therefore behaving exactly as did the nickel steel with the higher velocity.

It is the purpose of notched-bar testing to localize the deformation at the root of the notch, the surrounding material being so strengthened and stiffened by its greater bulk not to enter into the test. Furthermore, it is apparent that the amount of material deformed by the shock depends upon the shape of the notch. The author, therefore, investigated the effect of the diameter of the hole ending the notch, using specimens of steel C, 2 cm. wide. Examination of the fractured pieces by Fry's reagent showed deformed metal to the following depth from the broken surfaces:

Diameter of Notch	Depth of Deformation
1 mm.	0.4 cm.
2 mm.	0.8 cm.
4 mm.	1.4 cm.
6 mm.	1.6 cm.
10 mm.	1.8 cm.
13 mm.	1.95 cm.

Practically there exists no method for the accurate and quick determination of the volume of material which is deformed by a blow. It would furthermore be very desirable to determine an impact velocity suited to the material to be tested so that it would fall by deforming the predicted volume of material. Neither of these ends being commercially obtainable, the best recourse is to devise a form of specimen in which the errors in question are minimized. For this purpose a specimen 1 cm. square in cross-section at the root of the notch and having the notch end in a hole 4 mm. in diameter is preferable.

Electrical Precipitation of Solids From Smelter Gases*

Suspended solids in smelter gases are largely sulphides, sulphates and oxides, but the physical condition is of far more importance than the chemical composition. Dust of any sort is easy to precipitate in a Cottrell treater; condensed fume is extremely difficult. The author thinks this is due to the fact that the fume first gathering on clean electrodes is compact, smooth, and a high insulator; on the other hand, the angularity of dust particles causes them to build up a granular deposit, the pores of which are lined with jagged points and rough edges from which an electric charge can readily leak. Both the gas and the precipitated coatings must be kept conductive.

It is of utmost importance, therefore, to condition fume-laden gas before treatment. In fact, it is an operating maxim to "get the gas right and electrical troubles may be forgotten." While fume precipitation may sometimes be increased slightly by introducing true dust, the best way now known is to add a certain amount of water vapor or sulphuric acid mist.

Water vapor may be put into the flue by spraying a considerable quantity of water finely atomized by very high air pressure. Since the relative humidity for good clearance and a dry deposit must be kept between 40 and 70 per cent, it follows that the temperature of the gases must be largely reduced in order to attain this with a reasonable amount of water. In fact, the evaporation of the water is of prime importance in re-

ducing the gas temperature. Similarly, in winter it is often possible to cool the furnace gases by radiation so that their humidity will rise to the required limits. Mr. Rathbun believes that fume particles adsorb a surface film of water, which is held in the deposit without giving the appearance of moistness, yet having a great influence on its conductivity. Furthermore, humid gas is itself more conductive.

Conditioning with sulphuric acid is a more important method, since it permits good clearance on gas whose temperature (and therefore whose draft) has not been materially lowered. Sulphuric acid has a high enough boiling point so that it remains liquid at ordinary gas temperatures—it therefore aids conductivity because it actually wets the surfaces of the fume particles, spreading out at a very high rate. It also absorbs water vapor (and this water vapor must be supplied if the gas is naturally very dry) at temperatures well above 100 deg. C., so that the liquid films become dilute enough to be very good conductors of electricity. It is very necessary to add the acid at a high dispersion. This is effected best by boiling the acid and thoroughly mixing the mist with the gas to be treated—e.g., by spraying acid into the hot interior of a converter hood. If the solid particles react very rapidly, forming sulphates and thus wasting acid, conditioning must be done shortly before entering the treater, by an atomized spray of dilute acid. It has been found that good clearances are had in dust which contains from 1 to 5 per cent of free acid. Higher contents gives a sticky precipitate difficult to remove and handle. As high as two-thirds of the acid sprayed into the gas will pass through the treater.

Electrodes may be conditioned by slightly dampening them daily (or oftener if the fume contains much oxide) with fine H_2SO_4 mist. Acid appears to adhere to the collecting surfaces and absorb enough water from the passing gases to build up a continuous conducting coat.

Factice—A Rubber Substitute

A recent note published by the Stamford Rubber Supply Co. discusses the use of factice in rubber compounding. Factice is made from vegetable oils, ranging from the best imported French rapeseed oil to domestic corn oil. It is combined with sulphur chloride and the product thus formed, free from sulphur, from sulphur chloride and from the original oil, is called factice. It is a substitute for rubber and has often been called "rubber substitute." It has been found possible to use it in proofing cloth for clothing, hospital sheetings, carriage and automobile tops, etc. It is an economy to use it in this sort of work, as it cuts down the use of expensive solvents, such as gasoline, benzol, coal tar, etc., and permits a lighter, smoother spreading of the coating on the cloth. It is used in druggists' sundries, such as hot water bottles, and tubing, and numerous hard rubber articles. It is also used in tires to a limited extent, especially in the side wall, where from 5 to 10 per cent of the compound can be used. Bicycle tires can contain as high as 20 per cent of factice and even motorcycle tires use considerable amounts. And finally, it is used in mechanical work, such as belt frictions and covered stock or for conveyor belts, fire hose, etc. It has been in use in Europe for a long time among conservative and thoroughly reliable firms and it promises to have more extensive use in America in the near future.

*Abstracts of a paper read by Ross B. Rathbun, of the American Smelting & Refining Co., before the Vancouver convention of the American Institute of Electrical Engineers, Aug. 8, 1922.

Thermo-electricity

Since Seebeck conducted his original research, which covered a variety of phenomena, in 1821, a good many thermo-electric and electrothermic effects have been discovered and rediscovered over again. They are all interconnected; but three main effects may be distinguished, apart from the primary Joule effect—viz., that every conductor is heated by the electric current flowing through it. When the two metals of a heterogeneous circuit, consisting of two different metals in contact, are kept at different temperatures, an electric current is generated (Seebeck). When conversely an electric current is sent through that circuit, the junction is heated or cooled (Peltier, 1834). When the circuit is homogeneous and consists of one metal only, the temperature of which varies from point to point, however, an electric current is set up by the temperature difference (W. Thomson, 1856). The converse of the Seebeck effect, a generalized Thomson effect, had not been demonstrated, until Benedicks described his new X-effect. He claims to have established a direct "phoretic" transport of heat by the electric current, with or against the current direction, when flowing in a perfectly homogeneous conductor, of the same temperature throughout. The Thomson effect would only be a special case of this new effect. That heat transport would influence the Peltier and Thomson effects as usually measured; it would also play a part in the unipolar conduction of a crystal detector.

Investigation of Steel for Precision Gages

As an outcome of the organization of a committee of interested manufacturers and users (noted in *Chem. & Met. Eng.*, Feb. 8, 1922, p. 248), a 2-year program of research into the properties of gage steels has been agreed upon. Steels have been donated by the mills, the gages will be made by toolmakers, and the Ordnance

Department, U. S. Army, and the Bureau of Standards have financed the experimental work. Howard Scott has been chosen investigator and will devote his entire time to the problem.

Six types of steel are to be investigated: carbon steels with 0.85 C, 1.10 C, and 1.10 C, 0.5 Cr; ball bearing steel with 1.10 C, 1.40 Cr; non-deforming steel with 0.90 C, 1.25 Mn, 0.5 Cr, 0.5 W; and a nickel-chromium case-hardening steel. It is planned* to make fifteen thread gages and fifteen plug gages of each type, to study the influence of rate of heating before hardening.

A number of disks, 2½ in. diameter and 0.4 in. thick, are to be used to study the resistance to wear. While actual endurance in service is the ultimate test, a quick approximation is needed for an investigation, if for no other reason than to pick out steels worthy of service tests. Therefore the Amsler abrasion test machine is being studied. It produces dry wear on the periphery of two disks by a combination of rolling and sliding friction. Carbon steels are now being tested against oil-hardened steels in order to determine whether check runs give consistent results.

Changes in dimension on hardening are caused by at least two independent factors—viz., (a) temperature stresses due to non-uniform heating and cooling rates, and (b) volume changes due to the transformation of austenite to martensite. The former may be reduced by most careful control of the heat-treatment, a knowledge of the quenching power of the baths, or the use of an air-hardening steel. Given uniform cooling rates, the amount of distortion from austenite transformation should be uniform and predictable.

Slow changes in dimension on aging are probably due to a slow change in constitution of the steel; sudden changes to rearrangements of internal stresses. If these assumptions are true, the volume changes will be greatest and most rapid in untempered steel, and for investigative purposes it seems safe to assume that if a steel is stable as quenched, it will have better aging properties after tempering.

Machinability of a gage steel might best be studied by noting the temperature of the cutting tool when working under standard conditions.

These four tests—wear, changes upon hardening and subsequent thereto, and machinability—should permit one to determine readily the relative merits of a collection of commercial steels when used for gages.

A Steel Maker's Library

A number of leading men in the steel industry have been asked to select ten books on their specialty, which in their opinion would be most useful for inclusion in a business library to be installed in the Hotel McAlpin, New York. Replies were received from Charles M. Schwab, J. S. Unger, George G. Crawford, A. A. Corey, Jr., and John A. Mathews, citing the following books:

Title	Author	Publisher	Chosen By
Principles, Operations and Products of the Blast Furnace...	J. E. Johnson, Jr.	McGraw-Hill	Co, Cr, S, U
Metallurgy and Heat-Treatment of Iron and Steel...	Albert Sauveur	Sauveur & Boylston, Cambridge, Mass.	Co, Cr, S
Metallurgy of Iron and Steel...	Bradley Stoughton	McGraw-Hill	Cr, M, S
Manufacture and Properties of Iron and Steel...	H. H. Campbell	McGraw-Hill	Co, S, U
The Metallurgy of Steel and Cast Iron...	H. M. Howe	McGraw-Hill	Co, Cr, M
Basic Open-Hearth Steel Process...	Carl Dichmann	D. Van Nostrand Co.	Cr, S
Blast-Furnace Construction...	J. E. Johnson, Jr.	McGraw-Hill	Cr, U
Electric Furnaces in the Iron and Steel Industry...	Roehner, Schoenawa and Vom Baur	John Wiley & Sons	Co, M
Metallurgical Calculations...	J. W. Richards	McGraw-Hill	Co, Cr
Principles of Iron Founding...	Richard Moldenke	McGraw-Hill	Cr, U
The Making, Shaping and Treating of Steel...	Camp and Francis	Carnegie Steel Co., Pittsburgh, Pa.	Co, U
Cambria Steel Co. Handbook...			Co
Coal and Coke...	F. H. Wagner	McGraw-Hill	U
Heat-Treatment of Tool Steels...	Harry Brerly	Longmans, Green & Co.	M
Helmets and Body Armor in Modern Warfare...	Dashford Dean	Yale University Press	M
Iron and Steel...	H. P. Tieman	McGraw-Hill	Co
Iron and Steel Works Directory of the United States and Canada, 1920...			
Iron in All Ages...	J. H. Swank	American Iron & Steel Institute	U
Mechanical Engineer's Pocket Book...	Kent	American Iron & Steel Institute	M
Materials of Construction...	G. B. Upton	John Wiley & Sons	U
Metallurgy of Cast Iron...	T. D. West	John Wiley & Sons	M
Metallurgy of Steel, 2 vols...	Harbord and Hall	Cleveland Printing & Publishing Co.	S
Steel—A Manual for Steel Users...	W. Metcalf	Charles Griffin & Co.	S
Steel and Its Heat-Treatment...	D. K. Bullens	John Wiley & Sons	Co
The A B C of Iron and Steel...		John Wiley & Sons	Cr
The Chemical Analysis of Iron...	A. A. Blair	Penton Publishing Co., Cleveland, Ohio	U
The Electric Furnace...	Alfred Stansfield	Lippincott	Cr
The Engineering Index...		McGraw-Hill	S
The Inside History of the Carnegie Steel Co...	J. H. Bridge	American Society of Mech. Eng.	S
The Ore Deposits of the United States and Canada...	J. F. Kemp	Aldine Press	M
The Steel Foundry...	J. H. Hall	McGraw-Hill	U
Year Book...		McGraw-Hill	S
Journal...		American Iron & Steel Institute	S
		British Iron & Steel Institute	S

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Magnesium Chloride—Anhydrous magnesium chloride is prepared by the action of chlorine on a mixture of magnesium oxide and carbon at a temperature below the melting point of magnesium chloride, the reaction materials being preferably dry and the carbon free from gas. The reaction is started at 300 deg. C. or above, whereafter a sufficiently high temperature is maintained by the heat of the reaction. Fusion or sintering of the chloride may be prevented by keeping the charge in motion—for example, by carrying out the reaction in a revolving converter. The temperature of the charge may also be controlled by feeding in fresh quantities of material and by adjusting the velocity of the chlorine current. (Br. Pat. 181,375; not yet accepted. Aktieselskabet de Norske Saltverker, Bergen, Norway. Aug. 10, 1922.)

Basic Magnesium Chloride—Basic magnesium carbonate is obtained by emulsifying the normal carbonate with water at 40 to 50 deg. C. in a homogenizing apparatus having at least one turbine bucket wheel. A product of the composition $4\text{MgO} \cdot 3\text{CO}_2 \cdot 4\text{H}_2\text{O}$ is obtained. The normal carbonate may be obtained by mixing solutions of magnesium chloride and ammonium carbonate in an apparatus of the kind mentioned above, a product of the composition $\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$ being thus obtained. (Br. Pat. 181,388; not yet accepted. Chemische Fabrik Griesheim-Elektron, Frankfurt-on-Main. Aug. 10, 1922.)

Oxidation of Ammonia—The oxidation of ammonia by means of oxygen is effected by passing the gas mixture through a catalytic zone in which the concentration of the catalyst gradually increases in the direction of the gas flow; in this way mixtures containing up to 40 per cent of ammonia can be treated without explosion. The apparatus consists of a nickel or aluminum tube containing nickel rings, each of which carries a nickel net. Plates of platinized pumice are placed between the nets, the concentration of platinum increasing from the inlet to the outlet. The nickel nets and rings serve to conduct and radiate heat away from the reaction zone. (Br. Pat. 181,486. I. W. Cederberg, Lidingö-Brevik, and H. M. Bäckström, Djursholm, Sweden. Aug. 10, 1922.)

Purifying Acetylene—To basic materials such as a mixture containing ferric oxide and chloride, used for removing phosphoretted and sulphuretted hydrogen from acetylene, is added a

copper compound such as copper hydrate or chloride to act as a catalyst. The mixture is incorporated with kieselguhr, and to it, in addition to the copper compound, may be added a small proportion of mercuric chloride. Improved results are obtained if the mixture is kept for some months before use; when exhausted it is revived by exposure to the air. (Br. Pat. 181,571. J. R. Booser and District Chemical Co., London. Aug. 10, 1922.)

Synthetic Resins—Cyclohexanone or a homolog thereof is condensed with acetaldehyde, using an acid or alkaline condensing agent. The acetaldehyde in aqueous solution or otherwise is added gradually to a mixture of the cyclohexanone and condensing agent in a closed vessel and the whole stirred and heated. The product is cooled and stirred with water to remove soluble matter. Diluents or solvents may be employed. In an example, caustic soda acts as condensing agent and alcohol as diluent. The products may be employed as resin substitutes or in making varnishes, electric insulating compositions, etc. (Br. Pat. 181,575. H. Dreyfus, London. Aug. 10, 1922.)

Alumina—A solution of alum is treated with ammonia under such conditions that the alumina is precipitated in a readily filterable form. The alum solution is precipitated at a temperature near its point of ebullition, the ammonia is added gradually and the liquor is subjected to continuous agitation. An aqueous solution of ammonia may be introduced in the form of a spray into the alum solution, or preferably gaseous ammonia is injected, in order to utilize the heat of solution. After the removal of the alumina by filtration the potassium and ammonium sulphates are separated by crystallization, and the mother liquor is employed in the treatment of more alum. When the alum is obtained by hot lixiviation of crude material such as that obtained by treating leucite with sulphuric acid the precipitation may be effected advantageously directly while the solution is still hot. (Br. Pat. 181,678; not yet accepted. G. A. Blanc, Rome. Aug. 10, 1922.)

Imitation Metal Leaf—Thin films, particularly such as contain metal powder and serve as substitutes for metal leaf, are manufactured by applying a concentrated or pasty solution containing cellulose acetate, etc., and metal powder or pigment, by a single spreading operation on to a smooth support and then drying the film without further treatment. The support may be an endless band or a rotating drum or roller; and the solution may be supplied to a box in contact with the

support and having an opening in its bottom, and spreading effected by a knife or a roller which may be stiff or flexible, for instance of india rubber. (Br. Pat. 181,706; not yet accepted. Akt.-Ges. für Anilin-Fabrikation, Berlin. Aug. 10, 1922.)

Ferrocyanides—Coal gas, preferably freed from ammonia, is passed through a mixture of a ferrous salt and an alkali such as sodium carbonate, preferably containing no free alkali, oxygen being excluded and the reaction being effected in the cold. The liquor is then treated with an oxidizing agent, such as air, to oxidize sulphides while leaving the ferrocyanide and any sulphocyanide that may have formed unaffected. The liquor is then filtered, the filtrate being alkali ferrocyanide solution. Prussian blue is obtained by acidulating this solution and adding a ferric salt or, preferably, a ferrous salt followed by oxidation of the precipitate with air. The precipitate first separated, consisting of ferric hydrate and sulphur, is treated with dilute sulphuric acid, preferably at 60 deg. C., when the sulphur collects in lumps and ferric sulphate is obtained which may be used to oxidize the ferrous ferrocyanide. (Br. Pat. 181,719; not yet accepted. A. Dessemond and A. H. Delclevé, St. Etienne, France. Aug. 10, 1922.)

Starch—Starch is obtained from wheat flour by the action of a single protolytic enzyme such as pepsin or trypsin which is without action on starch or its cellulose envelope, but which converts the insoluble nitrogenous constituents of the flour into soluble substances which can be removed by water. In an example a mixture of pepsin, water and hydrochloric acid is heated to 40 to 50 deg. C., the flour then being added and the heating continued till the density of the liquor remains constant. The amount of pepsin employed is 0.04 per cent of the weight of flour. When the reaction is complete the liquor is separated from the starch in a centrifuge, the starch being intermittently washed with water till free from acid. If trypsin is employed, it is dissolved in a solution of sodium carbonate or bicarbonate. The starch is removed from the centrifuge and dried. Any gluten remaining in the starch may be removed by a solution of sodium hydroxide. The nitrogenous liquor obtained as a byproduct can be used as a fertilizer or as a base for foodstuffs. (Br. Pat. 182,829. F. H. Campbell, Melbourne. Sept. 6, 1922.)

Recovery of Sulphur—Sulphur in a pure state is recovered from an aqueous emulsion in which it occurs with gangue or other earthy matter by heating under pressure in an autoclave to a temperature above the melting point of sulphur but not exceeding 165 deg. C., the emulsion being agitated. Under these conditions the sulphur melts and may be separated by gravity from the aqueous liquid, the gangue, etc., remaining in suspension. The process may be applied to the mixture

of sulphur and flue dust obtained in the treatment of certain metallurgical gases. If, in addition to sulphur and gangue, metallic sulphides are present in the emulsion, they coalesce with the sulphur (which may be added if the amount originally present is insufficient) when the latter is melted as described above, the gangue remaining in suspension as before. (Br. Pat. 181,984. B. Hunt, London. Aug. 16, 1922.)

Dyeing Cellulose—Threads, filaments, strips or films of cellulose are dyed with vat or sulphuretted dyes by incorporating with viscose the leuco compound of the dye. The mixture or viscose and leuco coloring matter is preferably obtained by first bringing the dyestuff into solution and then mixing with the viscose, either as such or during its production. With a sulphur coloring matter sodium sulphide may be used in small quantities for this purpose, but it is preferred to replace it by sodium hydrosulphite. The use of large quantities of sodium sulphide is to be avoided. According to examples, Thional Black O.G., Duranthrene Blue C.C. and indigo are dissolved in caustic soda and sodium hydrosulphite and then mixed with cellulose xanthate. The mixture is spun in the usual way, and during the further treatment of the thread, particularly the washing and drying, the oxidation of the leuco compound proceeds. (Br. Pat. 181,902. Courtaulds, Ltd., London. Aug. 16, 1922.)

Dyeing Cellulose Acetate—Cellulose acetate goods are dyed direct in aqueous solution or suspension with non-sulphonated or monosulphonated soluble or insoluble dyes containing one or more of the following "active" groups: hydroxyl, amino, imino, imide, nitro, nitroso, isonitroso, acidylamino or azo groups; when a sulphonic group is present, the dye must contain at least two "active" groups. Carboxyl groups may be present or not. The dyes may be acid, basic or substantive dyes, vat dyes of the indigo or anthracene series, natural organic dyes, etc.

Salts which form double salts with basic dyes—for example, magnesium chloride, stannous chloride or zinc chloride—may be present in the dye bath when basic or other dyes are employed, or the basic dyes may be used in the form of such double salts. Examples are given of dyeing in an aqueous bath of galloxyamine DH, or in an aqueous foam bath of the kind described in specification 102,310 and containing insoluble Induline in suspension. (Br. Pat. 182,830. R. Clavel, Basel. Sept 6, 1922.)

Ammonium Sulphate—Commercial ammonium sulphate is neutralized by the addition of a solid neutralizing agent, preferably in powdered form, to the acid salt while it is being centrifuged. The neutralizing agent, which should be one capable of evolving a gas when in contact with the warm salt, is preferably added after the bulk of the mother liquor has been expelled, and is

introduced into the centrifuge so that it becomes spread on the inner surface of the crystals in the lower portion of the basket. The flow of the remaining liquor then disseminates the neutralizing agent, or the gas evolved therefrom, throughout the mass. The salt is preferably discharged from the centrifuge before neutralization is complete, the continued decomposition of the reagent in contact with the hot salt serving to complete the process and, in addition, to dry the salt. The amount of neutralizing agent required may be less than the theoretical. (Br. Pat. 183,089. G. Weyman, Gateshead-on-Tyne. Sept. 6, 1922.)

Book Reviews

ELEMENTS OF INDUSTRIAL HEATING. By the engineers of the W. S. Rockwell Co., New York City.

"The influence of heat upon the quality and cost of practically all manufactured products, and the comparatively inefficient methods in general use, indicate the necessity of developing a broader view of the industrial heating problem. The demand for better and cheaper products can only be met with better methods of heating and handling, better equipment and, above all, men better qualified to understand and properly apply in practice the simple principles of one of the oldest and most important, though indifferently practiced, industrial arts."

There is no doubt of the importance of the problems thus outlined in the preface of this book, and furthermore there is no doubt that the engineers who have prepared it have done much for industry in furnishing this well-illustrated, effective summary of important considerations in fuel application. Much of the material in this book has appeared in pamphlets previously issued, but when this material is brought together under one cover, it again emphasizes the complexity as well as the importance of the fundamental problems as these problems are seldom stressed.

One of the purposes of this new book is to bring together in convenient form for the use of chemical and mechanical engineering teachers material that may be employed as a "supplementary textbook for shop training classes, vocational schools, colleges, etc., as well as for the man in the shop and others interested in the subject." Several institutions have already announced that they expect their engineering students to use this pamphlet. If this practice is extended widely, as it well may be, we may look forward to the time when engineers will think not alone of cost of fuel per ton or the relative cost of various fuels per million heat units, but rather of that important over-all efficiency, the fuel cost per unit of quality product. In bringing out the importance of that feature, this book gives attention not alone to the selection of the fuel but also to the selection

of the furnace, the placing of the material in the furnace, the quality of product and the time factor in heating.

The book does not in any way argue for any single type of equipment or any particular fuel; it affords an unusually well-balanced and impartial review of the various types of heating furnaces, annealing equipment, automatic and continuous methods and the many variations of heat-applying devices that modern technology furnishes. It will be well worth while for experienced engineers as well as those beginning their studies in engineering to look through this booklet.

R. S. McBRIDE.

THE LEAD STORAGE BATTERY.

By H. G. Brown. 62 pp., illustrated. London, England: The Locomotive Publishing Co. Price, 5s. net.

As a handbook for those interested in the practical functioning of a storage battery, particularly stationary types, this book has considerable merit. It is exceptionally well written, being readable, clear and concise. The fundamental characteristics are given, but there is little attempt to discuss them and no attempt to include anything but very elementary theory.

The three opening chapters, which are largely introductory, deal with the chemistry of the lead cell, giving the familiar double sulphate theory. Characteristic voltage curves for charge and discharge are given and the influence of temperature is stated. A short chapter is devoted to a comparison of the Faure and Planté processes and characteristic structures and uses of each type of plate.

The main portion of the book, six chapters, is a discussion of stationary batteries, their construction, sphere of usefulness and maintenance. One chapter is devoted entirely to auxiliary apparatus such as boosters and automatic cut-outs. There are numerous wiring diagrams and the economies to be effected by the use of D. P. Battery Co., Ltd.'s, batteries are well advertised. All this material should prove of valuable assistance to the power plant engineer.

Unfortunately, however, the proportion of the industry interested in stationary batteries is much smaller in this country than in England. Only one chapter is devoted to our major product, portable batteries. This includes train lighting, vehicle, automobile starting and lighting and submarine, and, as far as it goes, is a good summary of the general demands in regard to voltage and capacity for each service and the types of batteries used. There are a few hints as to the care, but it is much too abbreviated to be of use to the American battery service station.

Since the book is so very well written both in regard to clearness of expression and the selection of essential facts, it is to be regretted that more emphasis has not been placed on the maintenance and repair of the portable type. Had this been included, the work would rank among the first of the storage battery handbooks. HELEN GILLETTE WEIR.

SYNTHETIC TANNINS: THEIR SYNTHESIS, INDUSTRIAL PRODUCTION AND APPLICATION.

By *Georg Grasser*, Lecturer in Tanning Chemistry at the German Technical College, Brunn. Translated by F. G. A. Enna. viii + 143 pages. New York: D. Van Nostrand Co., 1922. Price, \$4.

In the leather industry it has become customary to consider as tannins all materials which are capable of converting hide substance into in impure product. Without an understanding of this usage the term "synthetic tannins" is likely to appear misleading, since the chemical constitution of most of the industrial syntans bears not the slightest relation to that of true tannin. Indeed, much of the pioneer work on syntans was carried out before the chemical constitution of tannin was known. In order that this distinction may be clearly evident, the author devotes the first section to a review of the recent work on the synthesis of the true vegetable tannins. This is followed by a consideration of the different groups of syntans resulting from the condensation of phenols, hydroxy-benzenes, naphthalene derivatives and products containing the anthracene, di- and tri-phenylmethane groups. The tanning effects of mixtures and of natural products other than true tannins (including sulphite waste liquor) are next treated, followed by a short section on analytical methods.

Part II covers the industrial production and application of syntans. Naturally, since much of the author's work was done in the laboratories of the Badische Anilin und Sodafabrik, the products of this company receive practically exclusive attention. Much of the material in this part will be of interest to the practical tanner, and the book should find a place in every tanner's library. ALAN G. WIKOFF.

A TEXTBOOK OF CHEMICAL ENGINEERING. Second edition. By *Edward Hart*, Ph.D. 241 pages, 229 illustrations. Easton, Pa.: Chemical Publishing Co., 1922. Price, \$4.

Considerable additional information has been incorporated in the second edition of this book. New chapter headings include: Corrosion, Industrial Management, Pumps, Mechanical Handling of Materials, Autoclaves. Several of these could quite profitably receive more extended treatment in subsequent editions. It would seem that Professor Hart has formed the nucleus for a work which will become increasingly important as succeeding editions embody the suggestions which are sure to result from the author's earnest solicitations.

The author's perfect frankness on several points is quite refreshing. Thus, in speaking of obstacles to publication of information he says: "Boards of directors very often pursue the very silly policy of refusing to allow publication of information obtained in the working out of a process. The cry is that it has cost them much money and

they are therefore unable to reveal it to competitors. This is true in some cases, but it is nevertheless true that the publication of many results whose publication could do no possible harm is forbidden in pursuance of a narrow policy which the directors deny in public and practice in private. As a result of this, research departments are often little better than information departments whose chief aim is to steal methods from competitors."

While many valuable data are scattered throughout the volume, the impression made upon the reader by the work as a whole is that of a collection of miscellaneous notes grouped somewhat hastily rather than a careful, orderly presentation of the subject. More attention to this point might add greatly to the value of subsequent editions without in any way interfering with the textbook style. Logical arrangement is not inconsistent even in a textbook.

ALAN G. WIKOFF.

Synopsis of Recent Chemical & Metallurgical Literature

Comprehensive Study of Analyses of Coals

The results of analyses of hundreds of coals from 25 states and the Territory of Alaska are given in Bulletin 193, "Analyses of Mine and Car Samples of Coal Collected in the Fiscal Years 1916 to 1919," by Arno C. Fieldner, Walter A. Selvig and J. W. Paul, recently issued by the United States Bureau of Mines. Information as to the heating values of all coals tested is also given in the bulletin, which should be of interest to all extensive users of coal fuel.

Many mine samples of coal are analyzed each year in the laboratories of the Bureau of Mines. The analyses are made in connection with investigations relating to fuels belonging to or for the use of the United States Government, the causes of accidents in coal mines, the geologic relations of coal beds and the quality and the value of the coal and lignite in the public lands. The systematic collection and analysis of such samples in connection with fuel investigations were begun in 1904 at the government fuel-testing plant at the Louisiana Purchase Exposition, and were under the direction of the United States Geological Survey for 6 years. Descriptions of the coal samples collected between the beginning of this work, July 1, 1904, and the transfer of the fuel-testing and mine-accident investigations to the Bureau of Mines, July 1, 1910, were compiled and published in Bureau of Mines Bulletin 22. Descriptions and analyses of samples collected during the fiscal years 1911 to 1913 were published in Bureau of Mines Bulletin 85. Descriptions and analyses of samples collected during the fiscal years 1913 to 1916 were published in Bureau of Mines Bulletin 123.

In order that the material in this bulletin may be used to supplement that presented in Bulletins 22, 85 and

123, the same plan of geological classification has been followed, the analyses and descriptions of the samples being grouped in alphabetical order according to the states, county and town near which the mines or prospects sampled are situated.

Information regarding coal sampling and analytical methods employed by the Bureau of Mines and a bibliography on the coal resources of the world are contained in the bulletin.

The entire distribution of Bulletin 193 will be through the Superintendent of Documents, Government Printing Office, Washington, D. C., from whom the report may be obtained at a price of 35 cents. Bulletins 22, 85 and 123, the previously issued compilations of coal analyses made by the Bureau of Mines, are sold by the Superintendent of Documents at prices of 85, 45 and 50 cents, respectively.

Is Borax a Deleterious Constituent of Fertilizer?

Considerable interest during the past 5 years has been centered around the effect of borax in fertilizer on crops. This originated when the potash from Searles Lake was used in some mixed fertilizers and disastrous results followed. The reason for this was traced to the presence of borax in the fertilizer, and this in turn was traced to the Searles Lake potash. The recent paper of the United States Department of Agriculture, Bulletin 998 (July 3, 1922), by B. E. Brown of the Bureau of Plant Industry, is therefore extremely interesting. Experimental work was carried on during the year 1920 at various experimental fields of the Bureau of Plant Industry. Rows of potatoes were fertilized with a 4-8-4 mixture from nitrate of soda, sulphate of ammonia, cottonseed meal, muriate of potash and acid phosphate, the ammonia being derived equally from the three nitrogen sources. To this mixture was added 1, 2, 3, 4, 5, 10, 20, 30, 50, 100, 200 and 400 lb. respectively of borax per acre of ground. The yield from the various plots was compared. It is interesting that with 1, 2 or 3 lb. of borax per acre the plant growth is apparently stimulated, but when the borax is increased to 5 and 10 lb., marked injury and stunting of the plant is very evident. This effect is increased with 20, 30, 40 and 50 lb. of borax until with 100 and 200 lb. almost no plant growth is evident. From differences noted in the way in which the fertilizer is applied, it was found that if a week were permitted to elapse after the application of borax fertilizer, the effect of the borax was somewhat less, although not markedly so. This experimental work is a splendid contribution to the knowledge of the effect of borax on potatoes and is extremely interesting to the chemical industry in view of its connection with the Searles Lake potash. This potash, of course, has now been prepared free from borax so that no hesitation need be felt in its use. It served originally, however, to call attention to the borax problem.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields
Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Synthetic Chemical Interests Plan Tariff Change Appeal to Congress

Will Not Take Advantage of Appeal Under Flexibility Provisions of New Law Until After Attempt to Modify Rates in Congress

TARIFF duties on coal-tar products and synthetic organic chemicals from other than a coal-tar base will be the subject of attention when Congress reconvenes, although just what will be asked by the industries affected has not been made clear to the House Ways and Means Committee or the Senate Finance Committee.

From direct correspondence and other information received by the Finance Committee, it appears that at present there are three distinct movements in this connection to change the recently enacted tariff law and involving two, or more likely three, separate bills.

One of these movements looks toward a higher duty on synthetic organic chemicals and medicinals from other than a coal-tar base. The new tariff act gives these products a rate of 25 per cent ad valorem, foreign valuation. This was the rate recommended by the Finance Committee. The House used the same figure, but as the bill when it passed that body originally based ad valorem rates on American valuation, the result would have been much higher in cost of imports. The Bursum amendment, adopted by the Senate, placed these products on the same footing and with the same rates as coal-tar products, but after the various changes in conference the provision was stricken from the coal-tar paragraph and restored to an individual paragraph at the 25 per cent, foreign valuation duty. The duty on these products in the Underwood tariff varied, some being free and others bearing duty up to 20 per cent. However, for many months synthetic organic products were protected by the dye and chemical control act. This embargo was lifted with the effective date of the new tariff and the industry's protection dropped from an embargo to 25 per cent.

WILL APPEAL TO CONGRESS

Under the flexible tariff section, it would be possible for this industry to apply for relief through investigation by the Tariff Commission and Presidential proclamation increasing rates if the results of the investigation justified such action, but it is understood here that an effort first will be made to secure a higher rate direct from Congress. What rate will be asked has not been made known to the committees.

In connection with coal-tar products, two ideas have been suggested to the Finance Committee, which may be handled in a single bill or in separate measures, with the probabilities favoring the latter method if the ideas are to be pushed.

The first is to reclassify the paragraph on finished products entirely, and probably that on intermediates also, and to insert different duties for different products. The claim is advanced that some products do not require as high protection as given in the existing law, while others need much greater protection against foreign competition. The second suggestion is to remove the proviso in the Fordney-McCumber act which prohibits an increase in rates on coal-tar products under the flexible tariff section, these being the only rates to which this prohibition applies.

OVEREMPHASIZED DYES

Definite moves along these lines may be expected in a few weeks. Reception by Congress is of an uncertain nature. There is a strong bloc, especially in the Senate, which believes that the synthetic chemical industry has not been given adequate protection.

Friends of the industry believe that a mistake was made in the past in stressing dyes so strongly and that if at least equal emphasis had been put upon other features of the industry the results might have been different.

WOULD EXPAND TARIFF COMMISSION

The Director of the Budget has been asked to approve an appropriation of \$1,000,000 for the United States Tariff Commission for the year 1923-24.

A study of the new responsibilities devolving upon the commission under the administrative sections of the Fordney-McCumber tariff bill are so great that the members of the commission think the present appropriation should be trebled.

If the directors of the budget and Congress approve the request for the \$1,000,000 appropriation that the Tariff Commission has requested for the fiscal year 1924, a large expansion in the various commodity divisions will take place. The commission expects to enlarge its commodity division staffs all around, with the more pronounced increases in the sugar, chemicals and textiles staffs.

Franco-German Potash Combine Rumor Persists

Alsatian Company Admits Negotiations Relative to Division of U. S. Business

Reports persist that negotiations are under way looking to a division of the American potash market between Germany and France. French potash interests have repeatedly made the threat that they would enter into an agreement with the Germans if they did not secure a just share of the business in the American market. They advocate an allotment of 75 per cent of the American business to German producers and 25 per cent to France.

Inquiries made by the American Embassy at Paris at the request of the Departments of Commerce and State resulted in the following report to the latter department:

"The Embassy is informed by the Alsatian Commercial Co. that while conversations are being held relative to a potash agreement no decisions have yet been reached."

FRENCH PRODUCTION GROWS

Potash production in France increased during the second quarter of the current year, according to official French figures just furnished the Department of Commerce. The production during that quarter was 46,282 tons K₂O. The production during the first quarter was 38,733 tons.

A material increase is noted in the exports from France of the double sulphates of potash and magnesia. The exports of carbonated potash also have increased. On the other hand, there have been material decreases in exports of nitrate and chloride of potash.

The Sulphur Export Association

Taking advantage of the Webb law provision authorizing the organization of export associations, the three sulphur producers—namely, the Union Sulphur Co., the Freeport Sulphur Co. and the Texas Gulf Sulphur Co.—have entered into a combination for handling the sale of their product in foreign markets.

The new organization is to be known as the Sulphur Export Association and its officers are as follows: C. A. Snider, president; executive committee, H. D. Whitton of the Union Sulphur Co., E. P. Swenson of the Freeport Sulphur Co. and W. L. Aldridge of the Texas Gulf Sulphur Co. A board of directors, to consist of two representatives of each company, is still to be appointed.

Reparation Dye Plan Is Harmless to Industry

State Department Gives Assurance That American Dye Industry Will Not Be Jeopardized

No action toward the acceptance of reparation dyes to be credited against the United States' account for maintenance of American troops on the Rhine will be taken until Congress meets, the State Department has indicated, as legislation will be necessary to establish machinery for distribution.

Official word has come from the State Department that whatever is done in this matter will fully protect domestic interests and that the quantity of dyes to be accepted will be valued at only a small fraction of the American bill for troop maintenance. It was indicated that the value of the reparation dyes to be accepted under the contemplated scheme would be between \$3,000,000 and \$5,000,000 a year. In this connection it is pointed out that the life of the Reparations Commission, under the treaty of Versailles, has less than 3 years yet to run. It is said that the plan is acceptable to all of the Allies.

OUTLINE OF PROPOSAL

Under the treaties, the Reparations Commission is entitled to 25 per cent of the output of the German chemical works. Of this quantity, approximately one-fifth has been allotted the United States. Until recently, when the act expired, the character of the dyes accepted here has been regulated by the dye and chemical control act. The Textile Alliance has been acting as unofficial distributor, and the money paid by the consumers has been sent to the Reparations Commission.

The general idea of the pending proposition is to accept approximately the same quantity and the same character of dyes and have the money paid for them go into the United States Treasury to be credited against the bill for keeping American troops in the occupied areas of Germany.

MACHINERY FOR DISTRIBUTION

The machinery for the distribution of the dyes will be set up under executive authority, with Congressional sanction, it is stated. In advance of Congressional action, however, the State Department does not expect to reveal just how it will provide for the distribution. The Secretary of State declines to discuss how the prices of the dyes would be fixed or other details.

It has been intimated that probably authority will be asked to empower the President to dispose of this matter, which would enable him to designate any government department or any trade association for that purpose. A resolution to this effect was introduced in the Senate last July, but did not receive action before adjournment. However, assurance was given that the importation of the German dyes would not threaten with extinction the American dye or chemical industries.

There is no question about the deliv-

eries of the dyes. This has already been arranged for, it was stated. The only question remaining now is how they are to be sold.

Congress heretofore has been wary of taking any action which might be interpreted as involving the United States with the League of Nations, but under the circumstances here presented, when a method for partly collecting a foreign account is held forth, a more favorable view might be taken.

Chemical Engineers to Survey College Courses

In accordance with the vote of the Institute of Chemical Engineers at the June meeting in Niagara Falls, the council of the Institute has appointed a committee on chemical engineering education. The purpose of this committee is to obtain, as far as possible, the adoption of recommendations, embodied in the final report of the former committee on this subject, by the educational institutions. It is intended that, after 3 years' efforts to obtain this adoption, the committee shall select and publish the names of institutions offering chemical engineering courses which are approved by the Institute.

H. C. Parmelee, editor of *Chemical & Metallurgical Engineering*, is chairman of the committee, which is composed of ten other members, five of whom represent educational institutions and five the industry. The members who are interested primarily in educational work are Joseph H. James, W. K. Lewis, A. H. White, R. H. McKee and S. W. Parr. The members engaged primarily in industrial work are C. E. K. Mees, A. D. Little, C. L. Reese, W. C. Geer and W. R. Whitney.

Hoskins to Address New York Section of French Chemical Society

"Experiences of a Consulting Chemist" is the promising title of an intimate talk which will be delivered by Dr. William Hoskins, of Chicago, before the regular meeting of the American Section of Société de Chimie Industrielle, at the Chemists' Club, New York City, Oct. 13, 1922. All chemists and chemical engineers of New York and vicinity are cordially invited to be present at this meeting, which should be extremely interesting, as Dr. Hoskins' experiences have been wide and varied, and his reminiscences will no doubt be entertaining as well as instructive.

Tables of Data Issued for Zinc Chloride Solutions

A copyrighted zinc chloride solution table has been issued by the Manufacturing Chemists' Association. The table shows the relationship between Baumé degrees, specific gravity, concentration, weight per cubic foot and pounds of zinc chloride per cubic foot. Approximate allowances for temperature also are shown.

Leading Paint Men Select Technical Books

Leaders in Industry Express Choices for Ten Basic Books in Field

The basic books in the paint industry, as selected by leading members of the industry for inclusion in the business library of the McAlpin Hotel of New York, have been announced by L. M. Boomer, manager of the hotel. These selections came to Mr. Boomer as a result of an inquiry instituted among the leaders in the paint industry to assist him in building up a business library of the ten books in each of twenty industries selected by the leaders of those industries.

Among those giving selections from which final choice will be made are:

Paul S. Kennedy, industrial department, Murphy Varnish Co., Newark, N. J.; G. B. Heckel, secretary Paint Manufacturers' Association of the United States, Philadelphia, Pa.; R. L. Hallett, National Lead Co. research laboratories, Brooklyn, N. Y.; Nathaniel D. Chapin, the Billings-Chapin Co., Cleveland, Ohio; Henry A. Gardner, Institute of Paint and Varnish Research, Washington, D. C.; J. Sibley Felton, president Felton, Sibley & Co., Philadelphia; Maximilian Toch, vice-president Toch Bros., New York City; C. M. Lemperly, the Sherwin-Williams Co., Cleveland, Ohio; A. S. Butler, president McDougall Co., Inc., Buffalo, N. Y., and G. C. Morton, president Carpenter-Morton Co., Boston, Mass.

Among the books selected were:

The Manufacture of Varnish and Kindred Industries, Lévache and McIntosh; Varnishes, Oil Crusting, etc., Lévache and McIntosh; Drying Oils, Boiled Oils, etc., Louis E. Andes; D. Van Nostrand & Co., New York City.

Technology of Paint and Varnish, Sablon, John Wiley & Sons.

Quality Varnish, P. S. Kennedy, Murphy Varnish Co.

White Lead—Its Use in Paint, A. H. Sabin, John Wiley & Sons.

Red Lead and How to Use It, A. H. Sabin, National Lead Co., 111 Broadway.

Lead and Zinc in the United States, W. R. Ingalls, Hill Publishing Co.

Linseed Oil and Other Seed Oils, W. D. Ennis, D. Van Nostrand & Co.

Lead and Zinc Pigments, C. D. Holley, John Wiley & Sons.

An Introduction to the Study of Physical Metallurgy, Walter Rosenhain, D. Van Nostrand & Co.

Metallurgy of Lead, H. O. Hofman, Scientific Publishing Co.

Metallurgy of Lead, H. F. Collins, Charles Griffin & Co., Ltd., London.

Painters' Colors, Oils and Varnishes, Hurst, Chas. Griffin & Co.

Chemistry of Paints, Toch, D. Van Nostrand & Co.

German and American Varnish Making, Bottler and Sabin, John Wiley & Sons.

White Paints and Painting Materials, Scott, Modern Painter, Chicago.

Mixed Paints, Color Pigments and Varnishes, Holley and Ladd, John Wiley & Sons.

Paint Technology and Tests, Gardner, McGraw-Hill Co.

Paint Researches and Their Practical Application, Papers on Paint and Varnish; Gardner, P. H. Butler, Washington, D. C.

Proceedings of Scientific Section, Paint Manufacturers' Association of United States, P. H. Butler, Washington.

Paint Researches and Their Practical Application; Paint Technology and Test; Papers on Paint and Varnish, H. A. Gardner.

Corrosion and Preservation of Iron and Steel, Garner and Cushman.

Mixed Paints, Color Pigments and Varnishes, Drs. Holley and Ladd.

Paint Vehicles, Japans and Varnishes; Lead and Zinc Pigments; Dr. Holley.

Pigments, Paint and Painting, E. Berry.

A.I.C.E. to Establish Student Chapters

Amendment to Constitution Provides for Undergraduate Societies in Engineering Schools

The Council of the American Institute of Chemical Engineers has reported that the amendment to the constitution, printed in full below, has been passed by letter ballot of active members. This amendment provides for the establishment of student chapters of the A.I.C.E. at engineering schools of high standing where there is an active member of the Institute on the faculty.

REGULATIONS FOR STUDENT CHAPTERS

1. A student chapter in affiliation with the American Institute of Chemical Engineers, composed of students in a school of engineering of recognized standing, whose teaching staff includes an active member of the Institute, may be organized upon favorable vote by the Council. The name of such an affiliated society shall be "The _____ Students Chapter of the American Institute of Chemical Engineers."

2. The qualifications required of a proposed student chapter shall include:

(a) An organization of students in an engineering school of high standing which affords opportunity for specialization in chemical engineering;

(b) The endorsement of the application by the head of the chemical engineering department;

(c) A minimum membership of 12 students.

3. Each student chapter shall establish its own rules of government and procedure, which shall conform with any regulations which may be formulated by the American Institute of Chemical Engineers. It is also intended that each student chapter shall control the occurrence and character of its own meetings; but the American Institute of Chemical Engineers desires especially to aid in promoting the success and value of student chapters by frequent consultations and advice, as well as by arranging for speakers, on request, whose address will broadly supplement the class-work of the members. To this end the Council of the Institute will elect a councillor for each student chapter from among the active members of the Institute, who shall advise the student chapter in its relation to the parent society, and who shall transmit with his recommendations the report of the chapter called for in section 4.

4. Each student chapter shall submit an annual report, not later than the last day of May of each year, which shall include:

(a) A summary statement of the meetings held during the calendar year; giving the date of each, the attendance, the principal speaker and his subject, and other pertinent information;

(b) Names of the officers, and number of members, by classes, at the date of the report.

5. The annual dues of each student chapter shall be \$15 per year, subject to any regular assessment or increase of dues of active members of the Institute, which, under provisions approved by the Council, shall entitle it to the following:

(a) A copy of each issue of the *Bulletin* and *Transactions* of the American Institute of Chemical Engineers and of all papers and discussions printed as separates and programs of meetings;

(b) Attendance at meetings.

The annual dues shall apply to the current fiscal year and shall be payable in advance, due Jan. 1. The secretary of the American Institute of Chemical Engineers shall send out bills for dues each December for the following year. Student chapters admitted on or after July 1 of each year shall pay \$7.50 only for the balance of the current fiscal year.

6. Among the privileges offered to the members of student chapters are:

(a) Individual subscription to the *Transactions* of the American Institute of Chemical Engineers at a special price of \$4 per volume;

(b) To receive at cost, on request, copies of such separate papers as may be printed in pamphlet form;

(c) The right to attend the meetings of the American Institute of Chemical Engineers;

(d) The opportunity to hear, on special occasions, speakers whose personal experience qualify them to speak with authority upon the many questions which are of particular importance to the student during his college course.

7. Application for admission of student chapters to the American Institute of Chemical Engineers shall be in the form prescribed by the Council.

8. A student chapter may be disbanded upon its own request and with the approval of the Council, provided its annual dues for the current calendar year have been paid. The Council may discontinue a student chapter if its annual dues are not paid promptly, or if it becomes inactive, or if its continuance is considered not for the best interest of the Institute.

This step represents an attempt to supplement curriculum activities with advice and instruction which should be of value to the students in their professional work. Contact with the activities of the Institute should prove stimulating to the student groups.

Push Dam Construction at Muscle Shoals

Every effort is being made at Muscle Shoals to complete the excavation in cofferdam No. 2 and get the concrete in before high water. At present the work is being delayed somewhat by the difficulties of obtaining cement, sand and gravel. Progress would have been halted almost entirely had the Corps of Engineers not owned about 80 box cars. These box cars were handled in solid trains accompanied by convoys of Corps of Engineers men and used exclusively to bring in cement supplies. In this way it has been possible to avoid any serious slowing down of the cement work. Sand and gravel for this job come from a point down the river. Owing to the unusually low stage, great difficulty has been experienced in getting the floating equipment over the shoals.

COMPLETE IN 1925

As early next season as the water will permit it is planned to close the south channel and work actively in that cofferdam and in the powerhouse cofferdam. Unless unforeseen difficulties should arise, it is believed that the dam will have been completed early in 1925.

At the present time 1,100 men are at work at Muscle Shoals. To date there has been no difficulty in getting all the labor needed. The force, however, is to be expanded to about 2,000 and as the local labor supply already is under employment, some difficulty is expected in recruiting the additional labor which will be needed.

New York University Plans Courses in Ceramics

New York University has arranged to include the subject of clay products and clay products manufacture in a series of lectures on the geology of commerce and industry, soon to be started. The discussion will cover brick, tile and kindred products of the ceramic industry, dealing with the fundamental facts regarding the raw material situation, character and source of supply, methods and costs of preparing the raw materials for market, relation to other lines of industry, etc.

Iron and Steel Institute to Meet in New York

The twenty-second general meeting of the American Iron and Steel Institute will be held at the Hotel Commodore, New York City, on Friday, Oct. 27, 1922. A distinguished list of speakers have prepared papers to be read at the morning and afternoon sessions. Discussions from the floor will follow the reading of the paper. The complete program follows:

Address of the president, Elbert H. Gary, chairman, United States Steel Corporation, New York.

Modern Methods of Mining Coal, H. Foster Bain, director, Bureau of Mines, Washington, D. C.

The Storage of Bituminous Coal, H. H. Stock, professor of mining engineering, University of Illinois, Urbana, Ill., and J. V. Freeman, director, coal and coke research laboratory, United States Steel Corporation, Joliet, Ill.

Present Status of the Electric Furnace in Refining Iron and Steel, J. A. Mathews, Crucible Steel Co. of America.

Economic Importance of the Power Plant in the Steel Industry, E. F. Entwistle, Bethlehem Steel Corporation, Steelton, Pa.

The Steel Requirements of the Automotive Industry, C. H. Wills, president, C. H. Wills & Co., Marysville, Mich.

Heating Furnaces for Blooms, Slabs and Billets, W. P. Chandler, Jr., fuel and experimental engineer, Carnegie Steel Co., Duquesne, Pa.

Use of Liquid Fuel in Metallurgical Furnaces, R. C. Helm, director, Worcester research laboratory of the American Steel & Wire Co., Worcester, Mass.

The Thermal Efficiency of the Open-Hearth Furnace, C. L. Kinney, Jr., superintendent No. 1 open-hearth department, South Chicago Works, Illinois Steel Co., South Chicago, Ill., and G. R. McDermott, fuel engineer, South Chicago Works, Illinois Steel Co., South Chicago, Ill.

Fluorspar and Its Uses, G. H. Jones, president, Hillside Fluorspar Mines, Chicago, Ill.

Chemical Experts Needed on Tariff Commission

The Tariff Commission under the new law has greatly increased responsibility with respect to many import matters. A considerable number of experts will be required to carry out this work, and, among others, several chemists will be needed. At an early date it is desired to add specialists on heavy chemicals and essential oils. Such men should, of course, be graduate chemists with some years of industrial experience and should be competent to prepare reports on domestic production, international movement of chemicals, competitive conditions, costs, etc.

Persons interested in such positions should take the matter up with the Tariff Commission, Washington, at once, as some of this work must be undertaken at an early date.

Some Impressions of European Chemical Industries

New York Section, A.C.S., Hears Interesting Talks by Parsons, Hendrick and Brooks—British Editor Also Speaks

The fall season of society activities in New York City was opened last Friday by an enthusiastic meeting of the local section of the American Chemical Society. A fair proportion of the section's 2,100 members were on hand to listen to the stories brought back by our recent European travelers—Parsons, Hendrick and Brooks—and to an engaging talk by our distinguished visitor, Frederick E. Hamer, editor *Chemical Age* (London).

Preceding the program scheduled for the evening, Dr. Charles L. Parsons, as secretary of the national society, was given an opportunity to tell of the plans now being made for educating the public to the vital importance of chemistry in our economic life. Two proposals have been made. The first is that each section of the A.C.S. should appoint a member whose duty shall be to interview every Congressman and Senator from the district and see to it that they have a proper appreciation of the relation of our science to the country's industrial and social progress. The second plan, reported to have been proposed by Mr. Garvan, was that the society should interest chemical and allied manufacturers to give the industry national publicity in all of their advertisements by including the sentence: "*This Is a Product of Our American Chemical Industry.*"

DR. PARSONS BANQUETS AND DINES

Later in the evening in describing his recent trip to Europe, Dr. Parsons gave a detailed account of the Lyons meeting of the International Union of Pure and Applied Chemistry, in which as a vice-president he represented the United States. His constantly recurring references to the many banquets, dinners and lavish entertainments at Lyons and later at Marseilles brought forth many a hungry and thirsty sigh from his audience. A more serious comment on these entertainments, however, was the fact that in contrast to some of our own scientific meetings, they were always attended by Cabinet members and other high officials of government and state.

From a technical viewpoint nitrogen fixation is still the most important subject of industrial research in Europe. In England the Dillingham plant is about to be put in operation to produce 100 tons of ammonia a day. The big problem at the Badische works in Germany, according to Dr. Parsons, is not in the fixation reaction itself but in the economic production of hydrogen. Because of difficulties and expense connected with the carbon-steam method, a great deal of study has been given to electrolytic hydrogen. This process is believed by them to be the coming

method. Claude in France is said to have developed a process of taking hydrogen out of such gases as illuminating and coke-oven gas, by means of high pressures and low temperatures. Because of the quantitative recovery of such byproducts as benzol and ethylene it believed that the hydrogen can be obtained practically without cost.

BRITISH CHEMICAL INDUSTRIES

Mr. Hamer, who is in this country as a delegate to the meeting of the Associated Business Papers, Inc., declared that there is a growing feeling in England that the commercial and professional opinion of the industrial press offers better guidance to the government than does the manufactured politics of the daily papers.

Economic conditions in the British chemical industries have practically paralleled those in this country, according to Mr. Hamer's observations. Politically, however, he has reason to believe that they are better off in England than we are here. At least the government has definitely kept its promises to the chemical industries. The safeguarding of industries act, even with its shortcomings in administration and a strong opposition from the merchant class, has recently received a decidedly favorable vote of confidence by the British Parliament. Much of the credit for the general active condition of the British industry is due, Mr. Hamer believes, to the virile work of the Association of Chemical Manufacturers and its secretary, Mr. Woolcock; to the Chemical Engineering Group, the Chemical Industry Club, and various kindred organizations.

PERSONALITIES AND PROCESSES

Ellwood Hendrick's talk was mostly a bunch of anecdotes—interesting reminiscences of personalities and gossip about pleasant acquaintances made during his stay in London and his attendance at the meeting of the Society of Chemical Industry in Glasgow. He described the quaint customs, appearances and characteristics of some of England's foremost chemists, including such men as Sir J. J. Thomson, Sir William Pope, Professors Armstrong, Donnan and Ruttan, E. V. Evans and Stephen Miall. Finally, after threatening to exhaust his bountiful supply of superlatives, Dr. Hendrick described the interesting and business-like manner in which the Society of Chemical Industry conducted its annual meeting. There was the implication that some of our own societies could do well to emulate this excellent example.

Dr. B. T. Brooks closed the meeting with brief reference to a number of technological developments which had come to his attention while abroad. Most significant, perhaps, is the work in Germany on the hydrogenation of coal to produce liquid fuels resembling crude petroleum and yielding corresponding products on distillation. Over \$5,000,000 has already been spent in developing this process, which by simple hydrogenation under high pressures is said to result in an 80 per cent con-

Literature Needed by Russian Engineers

The need of Russian scientists and technologists for American literature is well known. The division of engineering of the National Research Council is constantly receiving requests from various institutions in Russia for recent American scientific literature. It is urged that persons having extra copies of scientific books, periodicals, publications of government and state scientific bureaus and scientific institutions, and authors' reprints of an original character or containing technical information, which have appeared since 1914, contribute them for this worthy cause.

All shipments for scientists in Russia should be sent by express, or if very heavy, by freight, to the American Relief Administration, care of Gertzen Co., 70 West St., New York City. Each consignment forwarded to New York should be accompanied by a list of the publications sent. This will enable the New York office and the committee to check up the shipment and its receipt and distribution in Russia. One copy of this list should be placed on top of the literature before the package is closed and five copies, together with all letters containing advices of shipment, express and shipping receipts, should be addressed to the American Relief Administration, Russian Scientific Aid, 42 Broadway, New York City. The cost of overseas transportation of all material forwarded to New York is borne by the American Relief Administration. Its distribution in Russia will then be arranged for by the Russian Academy of Scientists or a special committee representing recognized Russian scientific organizations in co-operation with local units of the A.R.A.

Australian Investigations on Tanning Materials

For some time past the Institute of Science and Industry has been carrying out investigations on tanning materials in Western Australia. Two of the more important of these investigations have now been completed. One relates to the Western Australian red gum, Marri kino. A suitable process has been devised for getting rid of the objectionable red color which this kino imparts to leather when tanned with it. The other relates to a comprehensive investigation of the tanning materials of Western Australia.

version of bituminous coal to liquid and gaseous products.

Another interesting reaction is the British process of hydrogenating CO to methyl alcohol. With a yield attained of 80 per cent, methanol can be produced at a cost of 1s. per gallon.

Dr. Brooks also referred to the Anglo-Persian Co.'s new process for using hypochlorite solutions instead of sulphuric acid in petroleum refining. A paper on this subject which was presented by Dr. Brooks at Pittsburgh will shortly appear in *Chem. & Met.*

Trade Commission Cites Turpentine and Celluloid Concerns

The Federal Trade Commission has issued a formal complaint against the Clifford Smith Co., of Richmond, Virginia, distributor of paints.

The respondent is charged in the complaint with exploiting, by advertising and by other means, a substitute for turpentine under the name of "Argentine turpentine," thus deceiving the purchasers of such commodity into the belief that the product is turpentine when such is not the case.

The Atlantic Comb Works, of New York City, has also been cited in a formal complaint by the Federal Trade Commission. The concern manufactures and sells toilet articles composed of nitrated cellulose or pyroxylin plastic, known commercially as "celluloid," "pyralin," "fibrelloid," "viscoloid" and by other names. This product resembles ivory in color and general appearance and the respondent, the complaint alleges, exploits the same under the title and designation of "White Ivory," thus deceiving the purchasing public into the belief that the articles so distributed by respondents are made of ivory in whole or in part.

Stockholders Ratify Merger of Electric Alloy With Atlas

Stockholders of both the Electric Alloy Steel and the Atlas Crucible Steel, of Dunkirk, N. Y., have formally approved a merger into the Atlas Steel Corporation, organized under New York charter. The capital structure of the new concern is \$2,000,000 bonds, \$1,000,000 debentures, \$2,000,000 of bank loans, \$500,000 of prior preference stock, \$6,000,000 of 7 per cent cumulative preferred stock, of which \$5,000,000 will be issued, and 100,000 shares of no par value of common stock.

The company will have an annual productive capacity of 45,000 tons of high-speed and special-analysis steel, and will be the second largest independent producer in its field in this country. L. J. Campbell, chairman of the board and chief officer, says the Youngstown offices of Electric Alloy will be closed and quarters established at Dunkirk.

New Cement Plants to Be Built in Birmingham District

The announcement by the Lehigh Portland Cement Co. that it will immediately construct a portland cement plant in Birmingham, Ala., on a block of land next to the Alabama byproducts plant assures the construction of two large cement plants which will cost approximately \$2,500,000 each. The estimated production of the Lehigh plant will be 1,000,000 bbl. per annum and that of the Phoenix recently announced 1,500,000 bbl. per annum.

The Lehigh plant will be built on 480 acres of land that is completely underlaid with limestone, thus giving an almost inexhaustible supply of one of raw materials.

Former Carnegie Steel Men Organize New Company

The Greenville Steel & Iron Co., recently organized at Greenville, Pa., has awarded a general contract to the McClintic-Marshall Co., Oliver Building, Pittsburgh, for the initial buildings for its proposed new plant on site lately acquired near the city limits, comprising about 35 acres of land. The structures will include an open-hearth furnace building, 100x150 ft.; 1-story rolling mill, wire-drawing mill, machine shop, warehouses, power house, and other mechanical buildings. At a later date it is proposed to construct a 500-ton blast furnace, additional rolling mills, foundry and other structures, to develop a maximum output of 350,000 tons of material per annum. Production will be devoted to steel castings, general steel products, wire specialties, etc. The entire plant is estimated to cost about \$2,500,000, including machinery. H. P. Bope, formerly connected with the Carnegie Steel Co., is president; H. E. McConnell, consulting metallurgical engineer, also previously associated with the Carnegie Co., will be managing director. The Greenville Chamber of Commerce is interested in the project.

Manufacturing Chemists Appeal for Regular Car Supply

Irregular car supply has so interfered with the handling of certain of the heavy chemicals and chemical raw materials that it has been necessary for the Manufacturing Chemists' Association to make formal representations on the subject to the car service committee of the American Railroad Association.

Personal

RAY W. AMES, professor of mining engineering, University of Illinois, gave an address at a recent meeting of the Dallas Technical Club, at the Mecca Café, Dallas, Tex.

RAYMOND K. BOWDEN, of Niles, Ohio, has been appointed instructor in metallurgy for 1922-23, at Carnegie Institute of Technology, Pittsburgh. Mr. Bowden leaves a position with the Crucible Steel Co. in Pittsburgh.

C. A. BROWNE was nominated as chairman of the New York Section of the American Chemical Society at the meeting on Oct. 6. C. E. DAVIS was nominated for vice-chairman and B. T. BROOKS for secretary-treasurer.

ROBERT S. BRADLEY has been elected chairman of the board of the American Agricultural Chemical Co., New York. GEORGE B. BURTON has been elected president.

F. E. HAMER, editor of *Chemical Age*, London, is in New York as representative of Benn Bros., Ltd., to the meetings of the Associated Business Papers, Inc., and the National Conference of Business Paper Editors. Mr. Hamer intends to visit Philadelphia, Wilmington, Baltimore and other Eastern in-

dustrial centers before his return to England, which he plans for about Oct. 28.

H. W. HARDINGE is returning from a 3 months' trip in Europe, on the S.S. Berengaria, which sailed Oct. 3. His trip was for the purpose of studying mining and industrial conditions in Italy, Switzerland, France and England.

I. M. JACOBSON, who has been at the University of Chicago doing graduate work, has returned to the Bureau of Standards, where he will be engaged on the problems of aviation chemistry. The work will include particularly the studies of balloon fabrics and dopes for treating airplane fabrics.

FRANK M. JONES of the research department, Brown Company, Berlin, N. H., will leave Nov. 1 to accept the position of chief chemist of the Durex Chemical Corporation at Sweetwater, Tenn.

A. L. PITMAN, until recently assistant director of the Bangor station of the Massachusetts Institute of Technology School of Chemical Engineering Practice, is now in charge of the institute's consulting work for the Tidewater Oil Co.

JOHN F. PRICE has been appointed vice-president of the George T. Trundle, Jr., Engineering Co., 118 St. Clair Avenue, Cleveland, Ohio. Mr. Price was formerly comptroller of the Brown Hoisting Machinery Co., Cleveland, Ohio.

DAVID J. PRICE, engineer in charge of development work in the Bureau of Chemistry, has been designated by Secretary Wallace to represent the United States Department of Agriculture and co-operate with the Chamber of Commerce of the United States in the nation-wide fire-prevention movement now being undertaken by that organization. In this campaign considerable attention will be given to industrial dust explosions and fires, and Mr. Price will serve on the National Fire Waste Council.

W. S. RUGH, Montreal, Que., gave an interesting illustrated lecture on the smelting industry before the members of the local Rotary Club, at a recent meeting at the Windsor Hotel.

E. P. SAWHILL has been placed in charge of conveyor sales of the Brown Hoisting Machinery Co., of Cleveland.

Obituary

HERBERT C. FOLLINGER, manager of the Chicago office of the Chain Belt Co., died of pneumonia at his home in Chicago, on Sept. 27. Mr. Follinger was 38 years of age at the time of his death. He was born at Fort Wayne, Ind. He became associated with the Chain Belt Co. in 1914, and in 1916 was appointed district manager for the Chicago territory.

JAMES LUND, vice-president of the Merrimac Chemical Co., who had been with the company 38 years, died at his home in Malden, Friday, Sept. 29, 1922.

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities
Prevailing Prices and Market Letters From Principal Industrial Centers

Present Trend of Coal Production and Prices

Progress Made Since Settlement of Coal Strike Indicates That a Possible Industrial Fuel Shortage Turns on the Question of Transportation Rather Than Mine Production

SLIGHTLY lower prices for soft coal and the widespread publicity given to Henry Ford's advice that coal buyers "delay purchases, as prices must drop further" have combined to bring about a situation in the coal market which may entail grave responsibilities to industry. In the opinion of the coal trade, as voiced by *Coal Age*, this can mean nothing but higher prices, "especially with transportation conditions as they are and will be this winter," and it is on the question of distribution rather than production that the issue rests.

It is estimated that at present 25 per cent of the motive power of the railroads is out of commission, and this is at a time when they are attempting to handle the peak of the year's coal business. The general belief is that present delayed purchases will result in a congestion following the resumption of business on a scale greater than can be cared for properly by the carriers.

PRODUCTION LEVELING OFF

Production of both bituminous coal and anthracite appears to have reached a temporary level, bituminous at around 9,750,000 net tons and anthracite at 1,850,000 tons a week. According to the reports of the Geological Survey, "the total of all coal raised is about 11,600,000 net tons, which is still somewhat less than the amount required to meet current consumption and the heavy movement up the Lakes, and at the same time to rebuild consumers' stocks."

OUTPUT OF ANTHRACITE AND BITUMINOUS

The output of anthracite during the week ended Sept. 30 was estimated to be between 1,800,000 and 1,900,000 net

tons, as against 1,856,000 tons in the preceding week.

The total production of bituminous coal, which is shown by weeks since 1919 in the accompanying chart, was estimated at from 9,600,000 to 9,900,000 tons. From these curves it will be observed that the present weekly rate of production is nearly a million tons above that of the year of depression, 1921, but is from one and one-half to three million tons below the years 1919 and 1920. Recent returns and figures for the cumulative production during 1922 for bituminous and anthracite coal and beehive coke will be found in Table I, prepared from data issued each week by the Geological Survey.

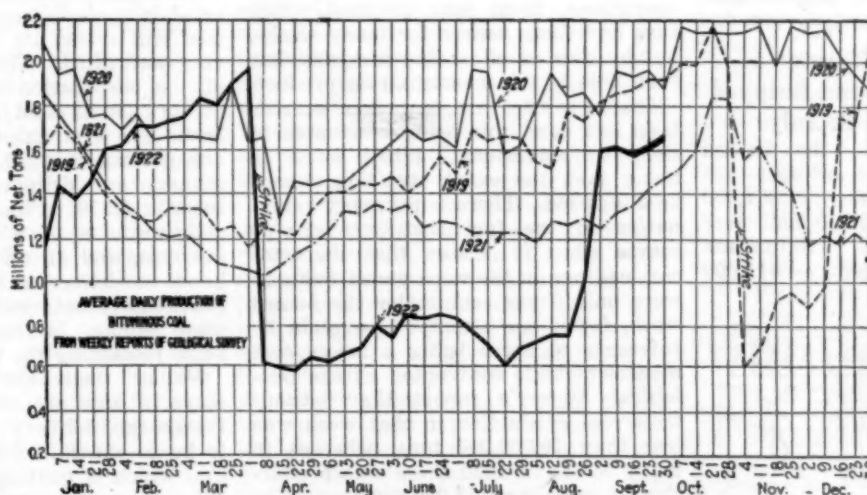


FIG. 1—ESTIMATED AVERAGE TOTAL DAILY PRODUCTION OF BITUMINOUS COAL

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week	150.78
Last week	150.14
October, 1921	151
October, 1920	263
April, 1918 (high)	286
April, 1921 (low)	140

Practically all of the gains reported last week were maintained and there were a few additional advances. Citric acid, borax and cottonseed oil quotations were somewhat higher and more than compensated for the slightly lower prices of caustic soda and linseed oil.

TABLE I—ESTIMATED PRODUCTION OF COAL AND COKE

(Net Tons)		
Bituminous Coal		
Week ended:	1921	1922
Sept. 9 (b)	7,083,000	8,791,000
Sept. 16 (b)	8,187,000	9,737,000
Sept. 23 (a)	8,527,000	9,702,000
Daily average	1,421,000	1,617,000
Calendar year	286,550,000	261,149,000
Daily average, cal. year	1,280,000	1,162,000
Anthracite Coal		
Sept. 9	1,483,000	50,000
Sept. 16 (b)	1,749,000	1,107,000
Sept. 23 (a)	1,725,000	1,856,000
Calendar year	67,759,000	25,224,000
Beehive Coke		
Sept. 16 (b)	64,000	123,000
Sept. 23 (a)	70,000	135,000
Calendar year	4,034,000	4,625,000

(a) Subject to revision. (b) Revised from last report.

BEEHIVE COKE PRODUCTION

Late returns for the week ended Sept. 16 reduced the estimates of beehive coke production in that week to 123,000 tons. Reports for the following week (Sept. 18-23) indicated an out-turn of 135,000 tons. This was nearly double the out-turn of the corresponding week in 1921, but was only one-third of the average weekly rate in 1920. Reports more recently received from the principal coke carriers indicate that during the last week of September the output jumped to 162,000 net tons, an increase over the preceding week of 18 per cent.

Cumulative production during 1922 stands at 4,625,000 tons. In the corresponding periods during the 4 years immediately preceding it was as follows:

1918	22,489,000	1920	15,695,000
1919	14,485,000	1921	4,034,000

Thus 1922 is 79 per cent behind 1918, 68 behind 1919, 71 behind 1920, and but 14 per cent ahead of 1921.

COAL PRICES

The *Coal Age* index of spot bituminous prices declined on Oct. 5 to 404, as compared with 418 for the preceding week. This corresponds to an average spot price of \$4.89 at the mines.

The General Rise of Commodity Prices

Wholesale prices, as measured by most of the general commodity indexes, have shown a distinct rising tendency except perhaps for August and September. The Bureau of Labor Statistics figure based on 404 commodities—including both raw materials and finished products—stood at 150 for June, increased to 155 for July and continued without change in August. The trends of the various groups are shown in Table II.

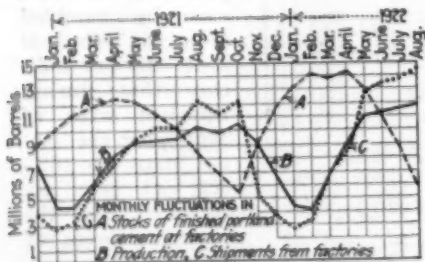
TABLE II—INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES (1913=100)

	June	July	Aug.
Farm products.....	131	135	131
Foodstuffs.....	140	142	138
Cloths and clothing.....	179	180	181
Fuel and lighting.....	225	254	271
Metals and metal products.....	120	121	126
Building materials.....	167	170	172
Chemicals and drugs.....	122	121	122
House-furnishing goods.....	176	173	173
Miscellaneous.....	114	114	115
All commodities.....	150	155	155

The twenty-five representative chemicals included in *Chemical & Metallurgical Engineering's* weighted index of chemical prices have declined for the most part during the past few months. There is reason to believe, however, that September's average of 147.70 marks the low point in the present movement and barring unfavorable developments at present unforeseen, a gradual and consistent improvement may logically be expected during the fall and winter months.

More Cement Made and Shipped in August Than in July

Cement production in the United States during August, according to the Geological Survey, totaled 11,864,000 bbl., an increase of 107,000 bbl. over the preceding month. Shipments amounted to 14,361,000 bbl., or 511,000 bbl. heavier than July.



PRODUCTION, STOCKS AND SHIPMENTS OF PORTLAND CEMENT, BY MONTHS, 1921-1922

Despite the fuel and car shortage, both production and shipments during August show improvement over July records. In fact, the August output exceeds that of the corresponding period in 1921 by 1,420,000 bbl. Shipments in August, 1922, showed an increase of 2,021,000 bbl. over the same month last year. A rate of shipment in excess of production left only 5,737,000 bbl. in reserve at the end of August, which was 2,696,000 bbl. under the stocks on hand July 31.

The Iron and Steel Market

PITTSBURGH, Oct. 6, 1922.

The recent curtailment in pig iron and steel production proves to have been no more than an episode. The rate of production in June had been the highest of the year and that rate is now practically regained. The deficiency in production in the three intervening months, from production that would have occurred with the June rate, is less than half a month's output at the June or the current rate. Undoubtedly a material part of the steel shipped up to Aug. 1 had been ordered as a safeguard against the coal strike interfering with steel production and the provision may easily have been ample to cover the slight restriction that occurred. Of late steel buyers have been menaced with transportation restriction. Now the restriction is a fact and there is danger of there being somewhat greater restriction.

TRANSPORTATION DIFFICULTIES

Car shortages, for shipping finished product, are experienced at most steel plants, and in some cases the shortages are very severe. The noteworthy item is that the Carnegie Steel Co. has piled 100,000 tons of finished and semi-finished steel, all of which should have been shipped as made. The American Sheet & Tin Plate Co. is motor trucking sheet bars from Duquesne to McKeesport and Monessen, and even at that has had approximately a 10 per cent reduction in its finishing mill operations, from lack of steel. Box cars have been scarce for many weeks, but by dint of effort the company has been able to ship nearly all its product.

Open-top cars are now even scarcer than box cars, this being attributed to the coal movement. While much is being said, the exact situation cannot be appraised. There is no ready explanation of the fact that cars are so scarce when it is seen that the total car loadings in the week ended Sept. 16 were only 6 per cent under the record week, for if one attempt to explain by reference to there being a heavy coal movement he is confronted by the Geological Survey's report that bituminous coal production in that week was less than 10,000,000 tons, whereas in many weeks in 1920 there was production of more than 12,000,000 tons. The fact simply remains that there is loud complaint that steel mills do not obtain enough cars to load all their product, while hitherto the complaint has been that not enough coal and coke was being received.

Advances in basis prices of finished steel products, for late delivery, appear to have ended. At the same time delivery premiums are tending to diminish. The prospect seems to be that within a few weeks all delivery premiums will have vanished. Later, it is likely that basis prices may decline somewhat. The swing is more easily predicted than the time. The general buying movement ended recently, present activity being in early deliveries only. Another general buying movement will scarcely

come until after there has been a period of quietness, during which some declines in basis prices can barely be avoided. The chief question is as to the extent of the prospective declines. The low point of early this year cannot be attained, as wage rates are much higher. Furthermore, it is impossible that sellers will again quote below cost, as it was claimed they did early this year. The experience then does not encourage a repetition now.

Events confirm the wisdom of the rail mills in their recent offer to book rails for the first half of 1923 at the old price of \$40, in anticipation of the advance to \$43, effective at the beginning of this week. Exact figures are not obtainable, but it appears that rails ordered will total considerably more than a million tons, while there has also been heavy buying of joints, bolts, spikes and tie plates, making a total business put under cover of about one and a half million tons. When the offer was first made it was not clear in all quarters that the mills would have spare production in the winter, but it is now plain that the orders will be needed in winter and probably in spring.

STEEL AND IRON PRICES

Bars and shapes are 2@2.25c. in the open market, depending on delivery and character of order, plates being 2.15@2.50c., but with little tonnage at above 2.25c. The Steel Corporation price seems to be 2c. on all three products, but buyers are no longer interested in such deliveries as the corporation can make, its order books being very well filled. The 3.35c. sheet price of the corporation is nominal, as the corporation is sold out until it opens books for first quarter. Independents are getting 3.50@3.60c., according to tonnage and delivery. Nails are uniform at \$2.70. Pipe prices are practically uniform, on a 68 per cent basing discount, and all mills are far behind-hand in deliveries of merchant pipe, particularly butt weld galvanized. Tin plate demand is seasonally poor, with \$4.75 remaining the regular market.

Valley merchant furnaces have scarcely any pig iron to offer. For Pittsburgh delivery the market seems to be in control of the Cambria Steel Co., which is quoting \$33 on bessemer, \$31 on basic and \$32.50 on foundry, f.o.b. Johnstown, with \$1.77 freight to Pittsburgh, the same as from the valleys.

Connellsville furnace coke is up 50c., at \$12@12.50, and foundry, still quotable at \$13.50@14, is stronger at that range. Offerings in the open market are very limited, although production on the whole continues to increase. The limiting factor is car supply, rather than the strike, this having been the case for about a month.

The Pittsburgh district coal market is lower, good grades of steam coal being available at \$3.50@3.75, or about 50c. less than a week ago. Gas coal is off about 25c. Byproduct coal is barely quotable and cannot be said to be easier.

The St. Louis Market

ST. LOUIS, Mo., Oct. 5, 1922.

Trading in the industrial chemical market has been along very active lines during the past two weeks, and from present indications should continue at this pace. Some of the heavy chemicals which have only been marking time for the past few months have now shown a remarkable improvement. This is particularly true of such items as phenol and some of the potash salts. Prices have been on the upward trend since the new tariff became effective, but are gradually firming up, and it is hoped that in a very short time the market will again be stable.

ALKALIS

Nothing beyond the ordinary has happened in the alkali market since our last report. Only a routine business is being transacted, but prices are firm at former levels. *Solid caustic soda* in 5- to 10-drum lots is still being quoted at \$3.90 per 100 lb. delivered buyer's door, with the usual differential prevailing for the flake. *Soda ash* is moving only through the normal channels, with prices the same as previously reported. In 5- to 10-bag lots \$2.20 per 100 lb. for the regular 58 per cent light is being quoted. *Bicarbonate of soda* has advanced slightly and is now being quoted at \$2.50 in 5-bbl. lots. In some instances this is being shaded slightly, but such is the exception and not the rule. *Sal soda* business is only routine, with prices a little weaker if anything.

GENERAL AND SPECIAL CHEMICALS

Heavy mineral acids are going very well, with a noticeable increase in the demand during the past month. Prices on all grades have been very strong with the exception of *muriatic*, which has been sluggish. Manufacturers report, however, that the former large stocks of this acid are now about depleted and that a firmer market will again be established. *Phenol* has been moving in large volume in spite of the sharp increase in price, and further advances would not prove surprising. Trading in *citric acid* since our last report has been quiet, but sales are still being restricted by manufacturers, which would indicate that spot stocks of domestic goods are very small. Prices are firm. Spot goods of *oxalic acid* are still difficult to locate and are being quoted at 17½¢@18¢, St. Louis. The demand has been exceedingly active. *Ammonia water* continues to move in a routine way, prices remaining the same. *White arsenic, powdered*, is ruling at 9¢. per lb. f.o.b. New York in carload lots, with a very strong market and a scarcity of supplies. The demand for *carbon bisulphide* has been along steady lines and prices very firm, which is explained by the fact that supplies have not been heavy and no surplus stocks accumulated this season. There has been very little change in the *copperas* situation—that is, so far as supplies are concerned—but since our last report producers have advanced their prices \$2 per ton and now

quote \$20@21 per ton in bulk, f.o.b. factory. *Glycerine* is going strong and the market is safely in the hands of producers. Our prediction of two weeks ago has been more than fulfilled and prices of 18½¢. in drums are being firmly maintained. *Sulphur* has eased up a bit in price and is now being quoted at \$1.90 in 50-bag lots. There is no natural cause for this decline in price, since the demand is at least normal. Price cutting among producers is probably the explanation. The market for *zinc dust* is very quiet with no change in prices, which are now being quoted at 9½¢. in carload lots, St. Louis. The *zinc sulphate* market is very strong at 3½¢. in carload lots, f.o.b. St. Louis. It would not be a surprise to see an advance very shortly.

VEGETABLE OILS AND NAVAL STORES

Castor oil has shown no inclination to weaken and the best that can be done now is 14¢. per lb. in drums for U.S.P. No. 1. This item is moving strong with a good demand and producers are in control of the market. *Turpentine* has wavered very little since our last report and is now quoted at \$1.41 per gal., as against \$1.40 when we last reported. *Linseed oil* has done little in the way of price changing and users are limiting purchases to immediate demands.

The New York Market

NEW YORK, Oct. 8, 1922.

Many of the chemicals imported in largest quantity have continued in the advance noted last week in these columns. Although transactions in the aggregate have not been materially greater than during the past few weeks, the general tone of the market has improved considerably. The industry, on the whole, is quite optimistic concerning future business.

An interesting comparison can be made with the market one year ago and at present. Then buyers were quite cautious on surplus material due to the downward tendency of prices and purchases were mostly of a hand-to-mouth nature. The capital issue in the present market is not how low prices are going, but to what extent the upward trend will continue. Yellow prussiate of potash was offered during the latter part of 1922 at 24¢. per lb. Present quotations range around 38¢. Citric acid sold at 42¢. during January and is bringing 52¢. per lb. on the spot market. Barium chloride was offered quite freely at \$50 per ton in 1922. The present market is exceedingly strong at \$105 per ton. The same sort of comparison also holds for acetic acid, acetate of lime, formaldehyde, oxalic acid, nitrite of soda, prussiate of soda, permanganate of potash and various other chemicals.

The most important feature of the week's activities was the advance by producers on all varieties of lead acetate. Imported caustic potash continues to head the list of most active imported items. Dealers are very firm in their demands for higher prices. Yellow prussiate of potash recorded a

late advance for spot goods. Commercial white arsenic has also been advanced and goods are very scarce for spot or nearby shipment. Lower prices were heard at the works on oxalic acid, the quotations for which had already discounted the effects of the new duty.

GENERAL AND SPECIAL CHEMICALS

Acetate of Lead—Manufacturers advanced prices on all varieties 1¢. per lb. White crystals are now being quoted at 11½¢. per lb. The demand continues to improve.

Arsenic—Prices for the white powdered are high and considerable activity has been reflected during the interval. November-December shipment sales have been made at 9½¢. per lb. The insecticide industry has again come into the market and contracted as far ahead as March. Spot goods range from 9½¢@10¢. per pound.

Bleaching Powder—Producers are quite firm in their views at 2¢. per lb. f.o.b. works in large drums. Small containers were bringing up to 2½¢. per lb. Demand is generally active.

Caustic Potash—Imported 88-92 per cent is being sold around 6½¢. per lb. The tone of the market is very strong and some dealers quoted higher figures. Consumers have shown added interest and leading factors recorded several carlot sales.

Caustic Soda—Export quotations were somewhat lower at \$3.45@3.50 per 100 lb. Goods for domestic consumption are bringing 3½¢@4¢. per lb. Contract prices remain quotably unchanged.

Chlorate of Soda—Domestic makers are quoting 6½¢. per lb., f.o.b. works. Imported material is held around 6½¢@6¾¢. per lb. A firm market with an advancing tendency is noted.

Nitrite of Soda—Imported material is obtainable in very limited lots at 9½¢. per lb. The inquiry has shown considerable improvement and the general tone of this market is much firmer.

Prussiate of Potash—Spot prices have been very firm during the week and all indications point to higher levels. Several transactions were reported at 38¢@38½¢. per lb. Supplies are very scarce and shipments seem to be around the same level as the spot market.

Prussiate of Soda—Dealers are holding stocks firm at 24¢@25¢. per lb. The demand is very active for moderate sized quantities. Shipment prices for November-December are offered at 24½¢. per lb., duty paid.

Sal Ammoniac—The white granular imported goods was quoted at 6¾¢@7¢. per lb. Domestic factors continue to quote 7½¢@8½¢. per lb. The gray variety is very scarce at 7½¢@8½¢. per pound.

WAXES

Beeswax—Conditions surrounding this market have been of a quiet nature and prices were somewhat irregular during the interval. Supplies were around the market in larger volume, with the pure white quoted at 36¢@40¢. per pound.

General Chemicals

Current Wholesale Prices in New York Market

		Carlots F.o.b. N. Y.	Less Carlots F.o.b. N. Y.
Acetic anhydride.....	lb.		\$0.38 - \$0.40
Acetone.....	lb.	\$0.16 - \$0.16	17 - 17
Acid, acetic, 28 per cent.....	100 lb.	2.80 - 2.90	2.95 - 3.50
Acetic, 56 per cent.....	100 lb.	5.60 - 5.75	5.80 - 6.25
Acetic, glacial, 99 per cent, carboys.....	100 lb.	11.00 - 11.25	11.50 - 12.00
Boric, crystals.....	lb.	11 - 11	11 - 12
Boric, powder.....	lb.	11 - 11	11 - 12
Citric.....	lb.	11 - 11	11 - 12
Hydrochloric.....	100 lb.	1.10 - 1.20	1.25 - 1.70
Hydrofluoric, 52 per cent.....	lb.	11 - 11	11 - 12
Lactic, 44 per cent tech.....	lb.	0.91 - 1.0	1.01 - 1.2
Lactic, 22 per cent tech.....	lb.	0.41 - 0.4	0.5 - 0.5
Molybdic, c.p.....	lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric).....	lb.		
Nitric, 40 deg.....	lb.	0.6 - 0.6	0.6 - 0.7
Nitric, 42 deg.....	lb.	0.6 - 0.6	0.7 - 0.7
Oxalic, crystals.....	lb.	1.6 - 1.6	1.6 - 1.7
Phosphoric, 50 per cent solution.....	lb.	0.7 - 0.8	0.8 - 0.9
Picric.....	lb.	2.0 - 2.2	2.3 - 2.7
Pyrogallol, resublimed.....	lb.		1.65 - 1.75
Sulphuric, 60 deg., tank cars.....	ton	9.50 - 10.00	
Sulphuric, 60 deg., drums.....	ton	12.00 - 14.00	
Sulphuric, 66 deg., tank cars.....	ton	15.00 - 16.00	
Sulphuric, 66 deg., drums.....	ton	19.00 - 20.00	20.50 - 21.00
Sulphuric, 66 deg., carboys.....	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....	ton	19.00 - 20.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....	ton	22.00 - 22.50	23.00 - 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....	ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....	lb.		60 - 75
Tannic (tech.).....	lb.	40 - 45	46 - 50
Tartaric, imported crystals.....	lb.		31 - 31
Tartaric acid, imported, powdered.....	lb.		31 - 31
Tartaric acid, domestic.....	lb.		32
Tungstic, per lb. of WO.....	lb.		1.00 - 1.10
Alcohol, ethyl (Cologne spirit).....	gal.		4.75 - 4.95
Alcohol, methyl (see methanol).....	gal.		
Alcohol, denatured, 188 proof No. 1.....	gal.		36 - 38
Alcohol, denatured, 188 proof No. 5.....	gal.		36 - 38
Alum, ammonia, lump.....	lb.	0.51 - 0.51	0.51 - 0.51
Alum, potash, lump.....	lb.	0.51 - 0.51	0.51 - 0.51
Alum, chrome lump.....	lb.	0.5 - 0.5	0.5 - 0.5
Aluminum sulphate, commercial.....	100 lb.	1.50 - 1.65	1.70 - 2.25
Aluminum sulphate, iron free.....	lb.	0.21 - 0.22	0.3 - 0.3
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	0.61 - 0.7	0.71 - 0.8
Ammonia, anhydrous, cyl. (100-150 lb.).....	lb.	30 - 30	30 - 31
Ammonium carbonate, powder.....	lb.	0.81 - 0.8	0.9 - 0.9
Ammonium nitrate.....	lb.	0.6 - 0.6	0.6 - 0.7
Amylacetate tech.....	gal.		2.35 - 2.50
Arsenic, white, powdered.....	lb.	0.91 - 0.9	1.0 - 1.0
Arsenic, red, powdered.....	lb.	1.2 - 1.2	1.2 - 1.3
Barium carbonate.....	ton	80.00 - 82.00	83.00 - 85.00
Barium chloride.....	ton	105.00 - 107.00	108.00 - 110.00
Barium dioxide (peroxide).....	lb.	20 - 21	21 - 22
Barium nitrate.....	lb.	0.9 - 0.9	0.9 - 1.0
Barium sulphate (precip.) (blanc fixe).....	lb.	0.4 - 0.4	0.4 - 0.4
Blanc fixe, dry.....	lb.	0.4 - 0.4	
Blanc fixe, pulp.....	ton	45.00 - 55.00	
Bleaching powder.....	100 lb.	2.00 - 2.10	2.15 - 3.25
Blue vitriol (see copper sulphate).....	lb.	0.51 - 0.51	0.6 - 0.6
Borax.....	lb.		
Brimstone (see sulphur, roll).....	lb.		
Bromine.....	lb.	27 - 38	28 - 35
Calcium acetate.....	100 lb.	2.75 - 2.85	2.90 - 3.25
Calcium carbide.....	lb.	0.41 - 0.4	0.5 - 0.5
Calcium chloride, fused, lump.....	ton	22.00 - 23.00	23.50 - 27.00
Calcium chloride, granulated.....	lb.	0.11 - 0.11	0.2 - 0.2
Calcium peroxide.....	lb.		1.40 - 1.50
Calcium phosphate, tribasic.....	lb.		15 - 16
Camphor.....	lb.		87 - 88
Carbon bisulphide.....	lb.	0.61 - 0.7	0.71 - 0.7
Carbon tetrachloride, drums.....	lb.	10 - 10	10 - 12
Carbonyl chloride, (phosgene).....	lb.		60 - 75
Caustic potash (see potassium hydroxide).....	lb.		
Caustic soda (see sodium hydroxide).....	lb.		
Chalk, precip.—domestic, light.....	lb.	0.41 - 0.4	
Chalk, precip.—domestic, heavy.....	lb.	0.31 - 0.3	
Chalk, precip.—imported, light.....	lb.	0.41 - 0.5	
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	0.5 - 0.5	0.51 - 0.6
Chloroform.....	lb.		25 - 32
Cobalt oxide.....	lb.		2.00 - 2.10
Copperas.....	ton	20.00 - 22.00	23.00 - 30.00
Copper carbonate, green precipitate.....	lb.	20 - 20	20 - 21
Copper cyanide.....	lb.		58 - 600
Copper sulphate, crystals.....	100 lb.	5.75 - 6.00	6.10 - 6.50
Cream of tartar.....	lb.		26 - 27
Epsom salt (see magnesium sulphate).....	lb.		
Ethyl acetate com. 85%.....	gal.		65 - 70
Ethyl acetate, pure (acetic ether, 98% to 100%).....	gal.		90 - 95
Formaldehyde, 40 per cent.....	lb.	101 - 101	11 - 11
Fullers earth, f.o.b. mines.....	net ton	16.00 - 17.00	
Fullers earth—imported powdered.....	net ton	30.00 - 32.00	
Fusel oil, ref.....	gal.		2.75 - 2.90
Fusel oil, crude.....	gal.		1.65 - 1.85
Glauber's salt (see sodium sulphate).....	lb.		
Glycerine, c.p. drums extra.....	lb.		18 - 18
Iodine, resublimed.....	lb.		4.40 - 4.50
Iron oxide, red.....	lb.		12 - 18
Lead acetate, white crystals.....	lb.		11 - 12
Lead arsenate, powd.....	lb.	13 - 13	13 - 14
Lead nitrate.....	lb.		15 - 20
Litharge.....	lb.	0.71 - 0.8	0.8 - 0.9
Magnesium carbonate, technical.....	lb.	0.6 - 0.6	0.6 - 0.7
Magnesium sulphate, U.S.P.....	100 lb.	2.00 - 2.25	2.30 - 2.50
Magnesium sulphate, technical.....	100 lb.		1.00 - 1.80
Methanol, 95%.....	gal.		70 - 71
Methanol, 97%.....	gal.		71 - 72
Nickel salt, double.....	lb.		11 - 11

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Nickel salt, single.....	lb.		12 - 12
Phosgene (see carbonyl chloride).....	lb.		
Phosphorus, red.....	lb.		40 - 45
Phosphorus, yellow.....	lb.		30 - 35
Potassium bichromate.....	lb.	10 - 10	10 - 11
Potassium bromide, granular.....	lb.		17 - 23
Potassium carbonate, U. S. P.....	lb.	12 - 12	13 - 16
Potassium carbonate, 80-85%.....	lb.	0.6 - 0.6	0.6 - 0.6
Potassium chlorate powdered and crystals.....	lb.	0.71 - 0.7	0.8 - 0.8
Potassium cyanide.....	lb.		55 - 57
Potassium hydroxide (caustic potash).....	100 lb.	6.50 - 6.60	6.65 - 7.00
Potassium iodide.....	lb.		3.45 - 3.55
Potassium nitrate.....	lb.	0.61 - 0.6	0.7 - 0.8
Potassium permanganate.....	lb.		18 - 19
Potassium prussiate, red.....	lb.	18 - 18	95 - 1.00
Potassium prussiate, yellow.....	lb.	38 - 38	39 - 39
Rochelle salts (see sodium potassium tartrate).....	lb.	0.61 - 0.7	0.71 - 0.7
Salammoniac, white, granular.....	lb.	0.71 - 0.8	0.81 - 0.8
Salammoniac, gray, granular.....	lb.		
Salsoda.....	100 lb.	1.20 - 1.40	1.45 - 1.60
Salt cake (bulk).....	ton	25.00 - 27.00	
Soda ash, light, 58 per cent flat, bags.....	100 lb.	1.60 - 1.67	2.00 - 2.25
Soda ash, light, 58 per cent flat, bags, resale.....	100 lb.	1.75 - 1.80	1.85 - 2.35
Soda ash, dense, in bags, resale.....	100 lb.	1.85 - 1.90	1.95 - 2.40
Sodium acetate.....	lb.	0.8 - 0.8	0.8 - 0.9
Sodium bicarbonate.....	100 lb.	1.75 - 1.85	1.90 - 2.30
Sodium bichromate.....	lb.	0.71 - 0.7	0.8 - 0.8
Sodium bisulphate (nitre cake).....	ton	4.50 - 4.60	4.65 - 5.50
Sodium bisulphate powdered, U.S.P.....	lb.	0.41 - 0.4	0.41 - 0.5
Sodium chloride.....	long ton	12.00 - 13.00	0.7 - 0.7
Sodium cyanide.....	lb.	1.91 - 2.1	2.1 - 2.5
Sodium fluoride.....	lb.	0.9 - 0.9	0.9 - 1.0
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract.....	100 lb.	3.35 - 3.40	3.75 - 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale.....	100 lb.	3.45 - 3.50	3.55 - 4.00
Sodium hydroxide (caustic soda), ground and flake, contracts.....	100 lb.	3.80 - 3.90	4.25 - 4.40
Sodium hydroxide (caustic soda) ground and flake, resale.....	100 lb.	4.00 - 4.15	4.40 - 4.60
Sodium hyposulphite.....	lb.	0.21 - 0.2	0.3 - 0.3
Sodium nitrite.....	lb.	0.91 - 0.9	1.0 - 1.0
Sodium peroxide, powdered.....	lb.	28 - 30	31 - 35
Sodium phosphate, dibasic.....	lb.	0.31 - 0.4	0.41 - 0.4
Sodium potassium tartrate (Rochelle salts).....	lb.		18 - 21
Sodium prussiate, yellow.....	lb.	24 - 25	25 - 25
Sodium silicate, (40 deg. in drums).....	100 lb.	80 - 1.00	1.05 - 1.25
Sodium silicate, (60 deg. in drums).....	100 lb.	2.25 - 2.40	2.45 - 2.75
Sodium sulphate, crystals (Glauber's salt).....	100 lb.	85 - 95	1.00 - 1.40
Sodium sulphide, fused, 60-62 per cent (conc.).....	lb.	0.4 - 0.4	0.41 - 0.5
Sodium sulphite, crystals.....	lb.	0.31 - 0.3	0.31 - 0.4
Strontium nitrate, powdered.....	lb.	0.91 - 1.0	1.01 - 1.2
Sulphur chloride, yellow.....	lb.	0.41 - 0.5	0.51 - 0.6
Sulphur, crude.....	ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra.....	lb.	0.8 - 0.8	0.9 - 1.0
Sulphur (sublimed), flour.....	100 lb.		2.25 - 3.10
Sulphur, roll (brimstone).....	100 lb.	2.00 - 2.15	2.20 - 2.70
Talc—imported.....	ton	30.00 - 40.00	
Talc—domestic powdered.....	ton	18.00 - 25.00	
Tin bichloride.....	lb.	10 - 10	10 - 10
Tin oxide.....	lb.		39 - 40
Zinc carbonate.....	lb.	14 - 14	141 - 151
Zinc chloride, gran.....	lb.	0.6 - 0.6	0.61 - 0.7
Zinc cyanide.....	lb.	42 - 44	45 - 47
Zinc oxide, XX.....	lb.	0.71 - 0.8	0.81 - 0.8
Zinc sulphate.....	100 lb.	2.75 - 3.00	3.05 - 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude.....	lb.	\$0.95 - \$1.00
Alpha-naphthol, refined.....	lb.	1.10 - 1.15
Alpha-naphthylamine.....	lb.	15 - 30
Aniline oil, drums extra.....	lb.	18 - 17
Aniline salts.....	lb.	22 - 24
Anthracene, 80% in drums (100 lb.).....	lb.	75 - 1.00
Benzaldehyde U.S.P.....	lb.	1.25 - 1.35
Benzene, pure, water-white, in drums (100 gal.).....	gal.	30 - 35
Benzene, 90%, in drums (100 gal.).....	gal.	28 - 32
Benzidine, base.....	lb.	85 - 95
Benzidine sulphate.....	lb.	60 - 85
Benzoic acid, U.S.P.....	lb.	72 - 75
Benzoate of soda, U.S.P.....	lb.	57 - 65
Benzyl chloride, 95-97%, refined.....	lb.	25 - 27
Beta-naphthol, tech.....	lb.	20 - 23
Beta-naphthol benzoate.....	lb.	3.75 - 4.00
Beta-naphthol, sublimed.....	lb.	53 - 55
Beta-naphthylamine, tech.....	lb.	23 - 25
Beta-naphthylamine, sublimed.....	lb.	1.50 - 1.60
Carbazol.....	lb.	75 - 90
Cresol, U. S. P., in drums (100 lb.).....	lb.	12 - 15
Ortho-cresol, in drums (100 lb.).....	lb.	16 - 18
Cresylic acid, 97-99%, straw color, in drums.....	gal.	56 - 65
Cresylic acid, 35-97%, dark, in drums.....	gal.	51 - 58
Dichlorobenzene.....	lb.	0.6 - 0.9
Diethylaniline.....	lb.	50 - 60
Dimethylaniline.....	lb.	32 - 34
Dinitrobenzene.....	lb.	20 - 22
Dinitrochlorobenzene.....	lb.	21 - 22
Dinitronaphthalene.....	lb.	30 - 32
Dinitrophenol.....	lb.	32 - 34
Dinitrotoluene.....	lb.	22 - 24
Dip oil, 25% car lots, in drums.....	gal.	72 - 75
Diphenylamine.....	lb.	54 - 56
H-acid.....	lb.	70 - 75
Meta-phenylenediamine.....	lb.	90 - 1.00
Monochlorobenzene.....	lb.	10 - 11
Monothylaniline.....	lb.	95 - 1.10
Naphthalene crushed, in bbls.....	lb.	0.6 - 0.6
Naphthalene, flake.....	lb.	0.61 - 0.7
Naphthalene, balls.....	lb.	0.71 - 0.8
Naphthionate of soda.....	lb.	58 - 65
Naphthionic acid, crude.....	lb.	65 - 70
Nitrobenzene.....	lb.	10 - 12
Nitro-naphthalene.....	lb.	30 - 35

Nitro-toluene.....	lb.	\$0.13	—	\$0.10
N-W acid.....	lb.	1.15	—	1.30
Ortho-amidophenol.....	lb.	2.10	—	2.15
Ortho-dichlor-benzene.....	lb.	.17	—	.20
Ortho-nitro-phenol.....	lb.	.80	—	.85
Ortho-nitro-toluene.....	lb.	.10	—	.13
Ortho-toluidine.....	lb.	.12	—	.14
Para-amidophenol, base.....	lb.	1.20	—	1.25
Para-amidophenol, HCl.....	lb.	1.25	—	1.30
Para-dichlorbenzene.....	lb.	.17	—	.20
Paranitroaniline.....	lb.	.72	—	.80
Para-nitrotoluene.....	lb.	.55	—	.65
Para-phenylenediamine.....	lb.	1.55	—	1.60
Para-toluidine.....	lb.	.85	—	.90
Phthalic anhydride.....	lb.	.35	—	.38
Phenol, U. S. P., drums.....	lb.	.21	—	.22
Pyridine.....	gal.	1.75	—	2.75
Resorcinol, technical.....	lb.	1.50	—	1.55
Resorcinol, pure.....	lb.	2.00	—	2.10
R-salt.....	lb.	.55	—	.60
Salicylic acid, tech., in bbls.....	lb.	.25	—	.27
Salicylic acid, U. S. P.....	lb.	.29	—	.30
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.27	—	.32
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.12	—	.14
Sulphanilic acid, crude.....	lb.	.24	—	.26
Tolidine.....	lb.	1.20	—	1.30
Toluidine, mixed.....	lb.	.30	—	.35
Toluene, in tank cars.....	gal.	.25	—	.28
Toluene, in drums.....	gal.	.30	—	.35
Xylidines, drums, 100 gal.....	lb.	.40	—	.45
Xylene, pure, in drums.....	gal.	.40	—	.45
Xylene, pure, in tank cars.....	gal.	.45	—	....
Xylene, commercial, in drums, 100 gal.....	gal.	.33	—	.35
Xylene, commercial, in tank cars.....	gal.	.30	—	....

Waxes

Prices based on original packages in large quantities f.o.b. N.Y.

Jayberry Wax.....	lb.	\$0.19	—	\$0.20
Beeswax, refined, dark.....	lb.	.30	—	.32
Beeswax, refined, light.....	lb.	.34	—	.35
Beeswax, pure white.....	lb.	.36	—	.40
Candelilla, wax.....	lb.	.34	—	.36
Carnauba, No. 1.....	lb.	.40	—	.42
Carnauba No. 2, North Country.....	lb.	.25	—	.26
Carnauba, No. 3, North Country.....	lb.	.19	—	.19
Japan.....	lb.	.15	—	.15
Montan, crude.....	lb.	.03	—	.04
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.04	—	.04
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.02	—	.02
Paraffine waxes, refined, 118-120 m.p.....	lb.	.03	—	.03
Paraffine waxes, refined, 125 m.p.....	lb.	.03	—	.03
Paraffine waxes, refined, 128-130 m.p.....	lb.	.04	—	.04
Paraffine waxes, refined, 133-135 m.p.....	lb.	.04	—	.04
Paraffine waxes, refined, 135-137 m.p.....	lb.	.05	—	.05
Stearic acid, single pressed.....	lb.	.09	—	.09
Stearic acid, double pressed.....	lb.	.09	—	.09
Stearic acid, triple pressed.....	lb.	.10	—	.10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$6.45	—	\$6.55
Rosin E-I.....	280 lb.	6.60	—	6.65
Rosin K-N.....	280 lb.	6.70	—	6.80
Rosin W. G.-W. W.....	280 lb.	7.75	—	8.25
Wood rosin, bbl.....	280 lb.	6.25	—	....
Spirits of turpentine.....	gal.	1.27	—	1.28
Wood turpentine, steam dist.....	gal.	1.15	—	....
Wood turpentine, dest. dist.....	gal.	1.12	—	.70
Pine tar pitch, bbl.....	200 lb.	....	—	6.00
Tar, kiln burned, bbl (500 lb.).....	bbl.	....	—	9.50
Retort tar, bbl.....	500 lb.	....	—	9.00
Rosin oil, first run.....	gal.	.38	—	....
Rosin oil, second run.....	gal.	.41	—	....
Rosin oil, third run.....	gal.	.48	—	....
Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	....	—	1.00
Pine oil, pure, dest. dist.....	gal.	.95	—	....
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	....	—	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	....	—	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75	—	....
Pine tar, ref., thin, sp.gr. 1.080-1.060.....	gal.	....	—	.25
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	....	—	.25
Pinewood creosote, ref.....	gal.	....	—	.52

Fertilizers

Prices remain quotably unchanged

Crude Rubber

Quotations same as previous report

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.12	—	\$0.13
Castor oil, AA, in bbls.....	lb.	.13	—	.13
China wood oil, in bbls.....	lb.	.12	—	.12
Coconut oil, Ceylon grade, in bbls.....	lb.	.08	—	.08
Coconut oil, Cochinchina grade, in bbls.....	lb.	.08	—	.09
Corn oil, crude, in bbls.....	lb.	.09	—	.10
Cottonseed oil, crude (f. o. b. mill).....	lb.	.07	—	.07
Cottonseed oil, summer yellow.....	lb.	.11	—	.11
Cottonseed oil, winter yellow.....	lb.	.12	—	.12
Linseed oil, raw, car lots (domestic).....	gal.	.87	—	.88
Linseed oil, raw, tank cars (domestic).....	gal.	.84	—	.85
Linseed oil, boiled, in 5-bbl lots (domestic).....	gal.	.90	—	.91

Olive oil, denatured.....	gal.	1.15	—	1.17
Palm, Lagos.....	lb.	.06	—	.07
Palm, Niger.....	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.08
Peanut oil, refined, in bbls.....	lb.	.12	—	.12
Rapeseed oil, refined in bbls.....	gal.	.78	—	.80
Rapeseed oil, blown, in bbls.....	gal.	.86	—	.87
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.11	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.09	—	.09

FISH

Light pressed menhaden.....	gal.	\$0.51	—	....
White bleached menhaden.....	gal.	.34	—	.35
Blown menhaden.....	gal.	.61	—	....
Whale Oil, No. 1, crude, tanks, coast.....	gal.	.45	—	.48

Miscellaneous Materials

Asbestos, crude No. 1, f.o.b. Quebec, Canada.....	short ton	\$600.00	—	\$800.00
Asbestos, shingle stock, f.o.b. Quebec, Canada.....	short ton	65.00	—	80.00
Asbestos, cement stock, f.o.b. Quebec, Canada.....	short ton	15.00	—	17.00
Shellac, orange fine.....	lb.	.61	—	.62
Shellac, orange superfine.....	lb.	.63	—	.64
Shellac, A. C. garnet.....	lb.	.62	—	.63
Shellac, T. N.....	lb.	.56	—	.57

All other prices remain quotably unchanged

Ferro-Alloys

Ferrotitanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrosilicon, per lb. of Cr contained, 6-8% carbon, carlots.....	lb.	.10	—	.10
Ferrosilicon, per lb. of Cr contained, 4-6% carbon, carlots.....	lb.	.10	—	.11
Ferromanganese, 78-82% Mn, domestic.....	gross ton	69.00	—	72.00
Spiegeleisen, 19-21% Mn.....	gross ton	38.00	—	39.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	63.00	—	65.00
Ferrosilicon 75%.....	gross ton	115.00	—	120.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.75	—	.80
Ferro-uranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	3.50	—	4.00

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried, f.o.b. shipping points.....	net ton	\$6.00	—	\$9.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	19.00	—	20.00
Coke, foundry, f.o.b. ovens.....	net ton	13.50	—	14.00
Coke, furnace, f.o.b. ovens.....	net ton	12.00	—	12.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	15.00	—	....
Fluorspar, standard, domestic washed gravel.....	net ton	17.50	—	19.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.45	—	....
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	net ton	70.00	—	75.00
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	.80	—	.85
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	27.00	—	....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.10	—	.11
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ , per lb. ore.....	unit	Nominal	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	lb.	.12	—	....
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	7.25	—	7.50
Uranium ore (carnotite) per lb. of U ₃ O ₈	unit	7.00	—	7.25
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	1.25	—	1.75
Vanadium pentoxide, 99%.....	lb.	2.25	—	2.50
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	12.00	—	14.00
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	1.00	—	....

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

Copper, electrolytic.....	Cents per lb.	14.00	—	....
Aluminum, 98 to 99 per cent.....	....	21.00	—	....
Antimony, wholesale lots, Chinese and Japanese.....	....	7.00-7.25	—	....
Nickel, ordinary (ingot).....	....	36.00	—	....
Nickel, electrolytic.....	....	39.00	—	....
Nickel, electrolytic, resale.....	....	32.00-33.00	—	....
Nickel, ingot and shot, resale.....	....	30.00-31.00	—	....
Monel metal, shot and blocks.....	....	32.00	—	....
Monel metal, ingots.....	....	35.00	—	....
Monel metal, sheet bars.....	....	38.00	—	....
Tin, 5-ton lots, Straits.....	....	32.75	—	....
Lead, New York, spot.....	....	6.35-6.50	—	....
Lead, E. St. Louis, spot.....	....	6.25	—	....
Zinc, spot, New York.....	....	7.05-7.10	—	....
Zinc, spot, E. St. Louis.....	....	6.75	—	....

OTHER METALS

Silver (commercial).....	oz.	\$0.69	—	....
Cadmium.....	lb.	1.15	—	....
Bismuth (500 lb. lots).....	lb.	2.20	—	....
Cobalt.....	lb.	3.00@3.25	—	....
Magnesium, ingots, 99 per cent.....	lb.	1.00@1.05	—	....
Platinum.....	oz.	\$112.00	—	....
Iridium.....	oz.	275.00@300.00	—	....
Palladium.....	oz.	55.00	—	....
Mercury.....	75 lb.	72.00	—	....

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

PHOENIX—The Southwestern Portland Cement Co., El Paso, Tex., has preliminary plans under way for the erection of a new plant on site selected near Phoenix, to consist of a number of buildings, with power house, etc., estimated to cost about \$1,200,000, including machinery. The new mill will give employment to a working force of about 200 men, and will be operated as a branch of the main plant at El Paso. O. J. Binford is secretary and general manager.

Alabama

BIRMINGHAM—The McWane Cast Iron Pipe Co., Birmingham, has awarded a contract to the Ingalls Iron Works, Birmingham, for the erection of the first unit of its proposed new plant on property recently acquired at East Birmingham, to be 105 x 340 ft., and equipped as a foundry for the production of cast iron pipe of small size. Other foundry units will be built at a later date. J. R. McWane is president.

Arkansas

MCRAB—The Reynolds Brothers Co. has tentative plans under consideration for the erection of a new plant on local site for the manufacture of brick, tile and other burned clay products.

California

LOS ANGELES—The Pacific Coast Borax Co., Kohl Bldg., San Francisco, has plans nearing completion for the erection of the initial unit of its proposed new plant in the harbor district, on site recently acquired, to be 2-story, 250x400 ft., with foundations to provide for the construction of three additional stories at a later date. With other projected structures, the plant will cost close to \$1,000,000, including machinery. Albert C. Martin, Higgins Bldg., Los Angeles, is architect.

Connecticut

NORWALK—The Meeker Union Foundry Co. has awarded a contract to the T. J. Pardy Construction Co., Bridgeport, for the erection of a new 1-story foundry, for the manufacture of iron castings.

Georgia

ATLANTA—The Vulcanite Roofing Co., Beaver Rd., Buffalo, N. Y., a subsidiary of the Beaverboard Companies, same address, has tentative plans under consideration for the erection of a new local plant for the manufacture of composition roofing products. A site is being selected.

Illinois

CHICAGO—The Benedict Stone Corp., 33 West 42nd St., New York, N. Y., manufacturer of composition stone products, has preliminary plans in progress for the erection of a new branch plant at Chicago. It is proposed to organize a subsidiary company to operate the works. The parent organization is arranging to increase its capital, the proceeds to be used for general expansion.

ELGIN—Construction has been commenced on a new 1-story foundry at the plant of the Woodruff & Edwards Co., State St., manufacturer of hardware products, to be 50x100 ft., and estimated to cost approximately \$100,000, including equipment.

Louisiana

MONROE—Thomas Stilwell, Anderson, Ind., associated with interests connected with the Lippincott Glass Co., Hartford City, Ind., is perfecting plans for the operation of a local plant for the manufacture of chimneys and kindred blown glass products.

Another plant will be operated at Cedar Grove, La. The operating companies will be of co-operative character.

Maryland

BALTIMORE—The Solarine Co., Emerson Bldg., manufacturer of metal polishes, etc., has awarded a contract to Frainie Brothers & Haigley, 19 West Franklin St., for the erection of its proposed 1-story plant at Eagle and Smallwood Sts., estimated to cost close to \$100,000, including machinery. E. H. Glidden, American Bldg., is architect. Harry A. Allers is president.

Massachusetts

EVERETT—The Stone & Forsyth Co., 67 Kingston St., Boston, manufacturer of paper products, has awarded a contract to the Blake & Pope Co., 50 State St., Boston, for the construction of an addition to its mill on Spring St., Everett, to be 2-story, 41x75 ft.

MALDEN—In connection with its new local plant building, for which contract recently was let, Wadsworth, Howland & Co. Inc., 139 Federal St., Boston, manufacturer of paints, varnishes, etc., is arranging an appropriation of approximately \$600,000 for the construction of a number of other plant units. Plans will be prepared at an early date. A research laboratory will be established in connection with the plant. The company has acquired the Ocean Paint Works, Inc., 211 47th St., Brooklyn, N. Y., and will operate this factory as a subsidiary; the plant has a capacity of about 1,000 gal. per day.

Michigan

MUSKEGON—The Central Paper Co. is completing plans for the construction of a new 3-story addition to its mill on Richard St., estimated to cost approximately \$200,000, with machinery. El J. Gaddes is secretary.

DETROIT—The Austin-Kelly Ink Co., 2270 Franklin St., has filed plans for the construction of a new 2-story plant on Bellevue Ave., near Sylvester St., estimated to cost approximately \$30,000.

MONROE—Plans are being completed for the construction of a new 1-story foundry addition at the plant of the Monroe Auto Equipment Co., to be 40x60 ft. Bids will soon be asked. A. P. Meyer is president.

SAGINAW—The Saginaw Chemical Co., 1618 North Michigan Ave., has preliminary plans under consideration for the construction of a plant on South Michigan Ave., consisting of two 1-story buildings, 68x100 ft. and 30x40 ft. respectively, estimated to cost about \$50,000. It is expected to call for bids early in the coming year. James C. Graves is vice-president.

Missouri

ST. LOUIS—The Reardon Co., 2200 South 2nd St., manufacturer of glue, paints and kindred products, has awarded a general contract to Hirsch & Co., Wainwright Bldg., for the construction of a 3-story and basement plant addition at 2nd and Clinton Sts., 40x80 ft., to cost approximately \$50,000. H. G. Clymer, Wainwright Bldg., is architect.

SPRINGFIELD—The Springfield Tanning Co., 214 Holland Bldg., formerly known as the Southwestern Tanning Co., has awarded a contract to the Pauly Construction Co., 741 South Ave., for the erection of its proposed 1-story and basement leather tanning plant, 100x135 ft., on West Commercial St. Work will be placed under way at once. W. R. Wolfe heads the company.

New Jersey

TRENTON—The New Jersey Porcelain Co., Pennsylvania and Mulberry Sts., has acquired a tract of property, fronting on New York Ave., extending from Strawberry to Plum St., as a site for the

construction of a new plant. Plans will be prepared at an early date.

STOCKTON—The B. C. Tillinghast Rubber Mfg. Co., recently organized under state laws, has acquired the local plant of the Stockton Rubber Co., which has been in control of a receiver for more than a year past. The new owner will make immediate improvements, including the installation of new machinery to cost about \$25,000. Employment will be given to about 50 persons for initial operations. Williams J. McLaughlin is vice-president and general manager; and Dominick Price, secretary and treasurer.

New York

NEW YORK—The Corn Products Refining Co., 17 Battery Place, has plans under consideration for extensions and improvements in its refining plants at Edgewater, N. J., and Pekin and Argo, Ill., to include the construction of new buildings and the installation of additional equipment. It is said that a fund of about \$3,000,000 has been arranged for the expansion. The company will also enlarge its plants in France and Germany, estimated to cost in excess of \$1,000,000, with equipment.

GOVERNOR—The Aldridge Paper Co., First National Bank Bldg., is considering plans for the construction of a new local plant, to cost about \$35,000. N. R. Caswell is head.

NEW YORK—The J. Spaulding & Sons Co., 481 Broome St., manufacturer of fiber products, will soon break ground for additional building at its plant on Wheeler St., Tonawanda, to cost about \$150,000, including machinery. The new structures will supplement a plant addition now practically completed, representing a cost of close to \$250,000. Plans are being prepared. George F. Hardy, 309 Broadway, New York, is engineer.

BUFFALO—Robert J. Gray, Dart St., near Bradley St., has made application to the city council for permission to equip a building at the location noted for a sherardizing plant, for zinc galvanizing and kindred work.

Ohio

NEWCOMERTOWN—The Canton Brick & Tile Co., New Philadelphia, O., is completing plans and will soon break ground for the construction of a 1- and 2-story plant on the Hardy Asher estate property, recently acquired. It will consist of a number of buildings, estimated to cost about \$250,000, with machinery. W. F. Demuth heads the company.

BEDFORD—The Mason Tire & Rubber Co., Kent, O., has plans in progress for enlargements at the plant of the Owen Tire & Rubber Co., Bedford, recently acquired. It is proposed to increase the capacity from 500 to 1,500 tires a day. The company has arranged for a bond issue of \$2,000,000, a portion of the fund to be used for the expansion.

NILES—The Brier Hill Steel Co., Youngstown, O., has plans in progress for the construction of proposed additions to its Thomas plant at Niles, to increase the capacity approximately 25 per cent. The installation will comprise new annealing furnaces, rolling mill equipment and other machinery, and is estimated to cost about \$1,000,000, including buildings. A fund of this amount has been appropriated.

Oklahoma

BLACKWELL—The Tower Gasoline Co., Oklahoma City, has preliminary plans under consideration for the construction of a new oil refinery on local site, to include a gasoline absorption plant. It is also proposed to construct additions to a number of present gasoline works in other districts. L. Z. Harrison is general manager.

HOLDENVILLE—Charles Morris, Holdenville, is organizing a company to construct and operate a local plant for the manufacture of brick, tile and kindred burned clay products.

Pennsylvania

PITTSBURGH—The Stroh Steel Hardening Process Co., Westinghouse Bldg., will construct by day labor its proposed new plant at Chateau and Ridge Sts., to consist of a number of buildings, including foundry for the production of steel castings. The plant will cost about \$250,000, with equipment. W. Y. Stroh is president.

CLARION—The Berner-Bond Glass Co. is said to have tentative plans under way for the rebuilding of its local plant.

destroyed by fire, Sept. 24, with loss estimated at close to \$400,000, including equipment. The works have been giving employment to about 200 operatives.

PHILADELPHIA—The Wilmet Fleming Iron & Steel Co., recently organized by Wilmet Fleming, 956 Foulkrod St., has preliminary plans in progress for the construction of a new 1- and 2-story plant on site selected at Cottman and G Sts., estimated to cost in excess of \$50,000. It will be equipped for the manufacture of general steel products. Mr. Fleming heads the company, and will act as engineer for the works. Others interested in the company are Paul E. Good and Joseph J. Carr.

PHILADELPHIA—The Paper Manufacturers' Co., 526 Cherry St., is razing the building at 5th, Willow and Randolph Sts., to make way for the construction of a new 5-story mill, estimated to cost in excess of \$75,000. Clarence C. Wunder, 1415 Locust St., is architect. Francis A. O'Neill is president.

EPHRATA—The Borough Council is arranging an ordinance providing an appropriation of \$30,000 for the construction of a filtration plant at the municipal water-works.

Tennessee

KINGSFORD—The Mead Fibre Co. has awarded a general contract to W. A. Allen, Kingsport, for the construction of its proposed 2-story and basement mill addition, 75x275 ft., to be equipped for the manufacture of paper products and for finishing work. The structure is estimated to cost about \$350,000, with machinery. The Management, Engineering & Development Co., Callahan Bank Bldg., Dayton, O., is architect and engineer, and will prepare plans for other future extensions estimated to bring the investment close to \$1,000,000.

CHATTANOOGA—The Debois Tube & Rubber Co. has preliminary plans in progress for plant enlargements to more than double the present capacity. The expansion is estimated to cost in excess of \$75,000.

Texas

HEARN—The Travis Cottonseed Products Co. is reported to be planning for the rebuilding of its oil mill, destroyed by fire, Sept. 17, with loss estimated in excess of \$100,000, including machinery.

HOUSTON—The Armstrong Steel Co., Fort Worth, is selecting a local site for the construction of a plant for the manufacture of steel products, to consist of an open-hearth furnace, mills and other structures, estimated to cost approximately \$1,000,000. The plant will be equipped for an annual production of about 60,000 tons. The present Fort Worth mills, with rated capacity of 40,000 tons per year, will be continued in operation. R. L. Van Zandt is president.

Utah

NEPHI—The Nephi Plaster & Mfg. Co. has plans under way for enlargements in its mill, to include the construction of a complete plant unit for the manufacture of agricultural gypsum products. The equipment installation will comprise grinding and crushing machinery, screening apparatus, power equipment, etc. The work is estimated to cost in excess of \$50,000.

Virginia

FREDERICKSBURG—The National Tanning Extract Corp. has acquired a local building, formerly used by the Wilson Dye Works, and will occupy the structure for the manufacture of tanning extracts. Improvements will be made and equipment installed at an early date.

HOPWELL—The Hummel-Ross Fibre Corp. has awarded a contract to the Wise Granite & Construction Co., American Bank Bldg., Richmond, for the construction of a 1- and 2-story plant, estimated to cost close to \$100,000, with machinery. The Joseph H. Wallace Co., 5 Beekman St., New York, N. Y., is architect and engineer.

Washington

SEATTLE—The Washington Iron Works, Inc., has awarded a contract to the Austin Co., Smith Bldg., for the construction of a 1-story foundry approximating 65,000 sq. ft. of floor space, to be equipped for the production of steel and gray iron castings.

MICA—The American Firebrick Co., Mica, near Spokane, has plans under way for the rebuilding of the portion of its No. 2 plant, recently destroyed by fire, with loss of about \$35,000, including equipment.

MT. VERNON—The Star Brick & Tile Co., Bay View, near Mt. Vernon, will soon commence the rebuilding of the portion of its

plant, recently destroyed by fire, with loss approximating \$25,000, including equipment. C. B. Mayhew heads the company.

West Virginia

CHARLESTON—The Libbey-Owens Co., Nicholas Bldg., Toledo, O., has plans in progress for the construction of six new additions to its local plant, ranging from 2-story, 45x240 ft. in size to smaller structures. The expansion is estimated to cost close to \$300,000, including equipment. A complete cutter shop will be installed. The DeVore Co., 908 Nicholas Bldg., Toledo, is architect and engineer. E. D. Libbey heads the company.

Wisconsin

GREEN BAY—The Fort Howard Paper Co. has commenced excavations for a new 2-story and basement building, 100x140 ft., at its plant, to cost about \$75,000. The general building contract has been let to the H. J. Selmer Co., McCartney National Bank Bldg.

MILWAUKEE—The Jelinek - Krueger Leather Goods Co., 416 4th St., is planning for the rebuilding of the portion of its plant, destroyed by fire, Sept. 9, with loss estimated at about \$25,000.

Canada

CALGARY, ALTA.—The Imperial Oil Corp., 347 Madison Ave., New York, N. Y., has tentative plans under consideration for the construction of a new oil refinery at Calgary, with gasoline extraction plant, designed for a capacity of about 2,500 bbl. per day. The initial plant will give employment to more than 200 men, and is estimated to cost close to \$2,000,000, with machinery. It is expected to commence construction early in the coming spring.

Capital Increases, Etc.

THE TRENTON LIME Co., Remsen, N. Y., has filed notice of increase in capital from \$40,000 to \$625,000, for proposed expansion.

THE LUDINGTON RUBBER Co., Ludington, Mich., has filed notice of dissolution under state laws.

THE McLAURIN-JONES Co., Brookfield, Mass., a consolidation of the Ideal Coated Paper Co., Brookfield; Ware Coated Paper Co., Ware, Mass.; and the Samuel Jones Co., Newark, N. J., specializing in the production of gummed papers, has arranged for a bond issue of \$400,000, the proceeds to be used for expansion and additions to working capital.

THE PEEL CHEMICAL CORP., 19 North Moore St., New York, N. Y., has filed notice of increase in capital from \$200,000 to \$450,000.

THE ENAMELED STEEL SIGN Co., 190 North State St., Chicago, Ill., has filed notice of increase in capital from \$50,000 to \$100,000.

THE ATLAS STEEL CORP., Dunkirk, N. Y., has been organized under state laws with a capital of 1,000 shares of stock, no par value, to take over and merge the Atlas Crucible Steel Co., Dunkirk, and the Electric Alloy Steel Co., Charleroi, Pa. Plants will be operated at the two places noted, and at Welland, Ont. Louis J. Campbell is head of the consolidated company.

THE EASTERN SUGAR CORP., a subsidiary of the Cuba Cane Sugar Corp., 112 Wall St., New York, N. Y., operating a refinery in Cuba, known as the Violeta Mill, has arranged for a bond issue of \$10,000,000, a portion of the proceeds to be used for expansion and additions to working capital. W. E. Ogilvie is president.

R. RICHARDSON HILL & Co., Inc., Saginaw, Mich., a Delaware corporation, has filed notice of change of name to the Old Hickory Dye-Chemicals Co., at the same time increasing its capital from \$300,000 to \$650,000.

THE GRAND RAPIDS GLUE Co., Grand Rapids, Mich., has filed notice of dissolution under state laws.

THE WHITELEY MALLEABLE CASTINGS Co., Muncie, Ind., has filed notice of dissolution under state laws.

THE SEAMAN PAPER Co., 208 South La Salle St., Chicago, Ill., has filed notice of increase in capital from \$3,000,000 to \$4,000,000.

THE GILL & HALL Co., Salem, Mass., manufacturer of leather products, has filed notice of dissolution.

THE CHOCTAW COTTON OIL Co., Ada, Okla., is planning for an increase in capital to \$2,500,000 for proposed expansion.

THE SUGAR ESTATES OF ORIENTE, INC., affiliated with the West India Sugar Fin-

ance Corp., 129 Front St., New York, N. Y., operating three sugar refineries in the Province of Oriente, Cuba, has arranged for a bond issue of \$6,000,000, for general operations, expansion, etc. Thomas A. Howell is president.

THE TRI-STATE PULP & PAPER CORP., High Bridge, N. J., has filed notice of increase in capital from \$8,000,000 to \$13,200,000.

THE MAGNA METAL CORP., Doremus Ave., Newark, N. J., has been reorganized with a capital of \$100,000, to manufacture a special metal similar to aluminum, and said to be lighter and stronger than such material. The operation of the present plant will be continued.

THE ARMSTRONG CORK Co., Pittsburgh, Pa., has called a special meeting to approve an increase in capital from \$17,000,000 to \$30,000,000.

THE UTILITY COLOR & CHEMICAL Co., 700 Broad St., Newark, N. J., has filed notice of dissolution.

THE DUNLOP RUBBER Co., River Rd., Buffalo, N. Y., is said to be planning for a bond issue of \$10,000,000, for general operations, expansion, etc.

C. G. Ludvig has been appointed receiver for the FLOROME CHEMICAL CORP., 24 Wooster St., New York, N. Y.

THE ARMOUR LEATHER Co., Chicago, Ill., has taken title to the plant and business of Alexander Brothers, Inc., Philadelphia, Pa., manufacturer of leather products, for a cash consideration said to be \$806,000.

Robert A. Messler has been appointed receiver for the TRENT BRICK Co., Brunswick Ave., Trenton, N. J.

Industrial Developments

LEATHER—The American Hide & Leather Co., New York, has adopted a full-capacity schedule at its side leather plant at Ballston Spa, N. Y. The Woburn, Mass., tannery of the company, devoted to patent leather production, has been advanced to about 75 per cent of normal. The Western plants are increasing their operating schedules, with the Sheboygan, Wis., tannery running on a 70 per cent production basis.

Howe Brothers, Boston, Mass., are arranging for increase in operations at their sole leather tanneries.

The American Oak Leather Co., Boston, Mass., is said to be arranging for the removal of its cutting plant from South St. to a building on Congress St., for immediate increased production.

The Crescent Leather Co., Woburn, Mass., manufacturer of patent leather, has advanced operations to a working basis of about 1,000 sides a day.

RUBBER—The Dayton Rubber Mfg. Co., Dayton, O., is running full at its local plant, with monthly averages higher than ever before in the history of the company.

The Republic Rubber Co., Youngstown, O., is advancing production at its local mills. It is expected to resume operations in full at the tire-manufacturing department within a few weeks. The Canton, O., mill of the company is now running on a normal basis, with regular working force.

After a number of weeks idleness, **John P. Hill, receiver for the Hydro United Tire Co., Pottstown, Pa.**, has reopened the plant on a basis of 600 tires a day, giving employment to a working force of about 300 persons.

The Goodyear Tire & Rubber Co., Akron, O., is resuming normal production at its No. 2 plant, devoted to the manufacture of tires for Ford automobiles, following the recent curtailment.

PAPER—The York Haven Paper Co., York Haven, Pa., is running under heavy production, giving employment to a regular working force. A 10 per cent wage increase has been made at the mill, effective Oct. 1.

The American Writing Paper Co., Holyoke, Mass., has advanced production at its different state mills, and is now operating in excess of 85 per cent of capacity.

The Castanea Paper Co., Lock Haven, Pa., has increased the wages of operatives at its local mill. All departments are running full.

The Alaska Pulp & Paper Co. has resumed operations at its Speel River, Alaska, mill, following a suspension for some time past. It is expected to keep the plant in service throughout the winter.

The New York & Pennsylvania Co., Lock Haven, Pa., is maintaining active production in all departments at its local mill. A wage advance of 3c. an hour has been granted employees.

OIL—The Wortham Refining Co., Wor-

tham, Tex., is planning for the early resumption of operations at its local petroleum refinery, following a curtailment for a number of weeks past.

The Mexico Petroleum Co., New York, is operating its refining plant at Tampico, Mexico, at maximum capacity, and expects to continue on this basis for an indefinite period.

The Skelly Oil Co., Midland, Okla., is operating in all departments at its refineries and byproducts plants. An average of 75,000 bbl. of crude oil per month is being run through the stills, with output devoted to fuel oil, kerosene, gasoline, naphtha distillate, gas oil and lubricating oils.

IRON AND STEEL—The Cleveland-Cliffs Iron Co., Cleveland, O., is arranging for the resumption of operations at its iron and chemical plants at Gladstone, Mich., on Oct. 15, following a suspension for some time past. This will be the last charcoal furnace to be placed in blast in the state, making 100 per cent operation of such furnaces for the first time since 1920.

The Carnegie Steel Co., Youngstown, O., has placed its Lower Mill furnace in blast, bringing production to close to 100 per cent in this district. Only one company furnace is now idle.

The United States Steel Corp. is increasing production at its mills in the Wheeling, W. Va., district to close to normal. The Wheeling Steel Co. and the Whitaker-Glessner Co. mills in this section are also running full. The Yorkville, O., plant of the Wheeling company is now on a 75 per cent operating basis.

The Gulf States Steel Co., Birmingham, Ala., has advanced the wages of employees at its Gadsden, Ala., plant, 10 per cent. About 2,000 men are affected. This makes the second such increase within the past three months. The mill is running full.

The Nagle Steel Co., Pottstown, Pa., recently organized with a capital of \$300,000 by George H. Heck, 518 Commercial Trust Bldg., Philadelphia, Pa., and associates, has taken over the plants of the company of the same name at Pottstown and Seyfert, Pa., secured from the receiver. The new company has resumed production at the Pottstown mill under double shift working force, and plans to reopen the Seyfert plant before the close of the month.

The Republic Iron & Steel Co., Youngstown, O., is making ready for operation at the fifth furnace at its Hazleton plant. Four units are now in blast. Work is also under way at its Hanna furnace, and this unit will soon be blown in.

The Reading Iron Co., Reading, Pa., has placed its local sheet mill in operation, giving employment to about 250 men. The plant has been idle for about 6 weeks past.

The Midvale Steel & Ordnance Co. is arranging for the immediate blowing in of the second blast furnace at its Coatesville, Pa., plant.

New Companies

THE ASTOR CHEMICAL CORP., New York, N. Y., care of Bickerton, Willenberg & Fleischer, 220 West 42nd St., representatives, has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are L. E. Meyers, B. White and E. Weisberg.

THE SOUTHERN TANNING & MFG. CO., Punta Gorda, Fla., has been incorporated with a capital of \$50,000, to manufacture leather products. J. T. Swinney is president; T. C. Crosland, vice-president; and W. W. Knight, secretary-treasurer, all of Punta Gorda.

THE COLONIAL BRICK CO., Cliffwood, N. J., care of Fred Hankins, Cliffwood, representative, has been incorporated with a capital of \$100,000, to manufacture brick, tile and other burned clay products. The incorporators are Orman W. Ketchum, Frank J. Bell and George M. Craigen, all of Cliffwood.

THE FIXEM MFG. CO., Detroit, Mich., has been incorporated with a capital of \$35,000, to manufacture special powders, chemical specialties, etc. The incorporators are Carl Wrobel, M. Peters and Alfred P. Norton, 3066 Van Dyke Ave., Detroit.

THE AMERICAN JAPANING CO., Woburn, Mass., has been incorporated with a capital of \$10,000, to manufacture japanned metal products, etc. James J. Finnegan is president; and Samuel Gorin, 9 Allen St., Boston, treasurer.

THE INTERCONTINENTAL RUBBER PRODUCTS CORP., New York, N. Y., care of the Registrar & Transfer Co., 900 Market St., Wilmington, Del., representative, has been

incorporated under Delaware laws with capital of \$6,040,000, to manufacture rubber products.

THE FIMA LABORATORIES, INC., Rochester, N. Y., care of G. B. Wesley, attorney, Rochester, representative, has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are W. Mathie, R. J. Fisher and H. E. Moore, all of Rochester.

THE MICHIGAN STEEL CORP., Jersey City, N. J., care of the Corporation Trust Co., 15 Exchange Place, Jersey City, representative, has been incorporated under state laws to manufacture steel sheets and other steel products. The capital is 22,000 shares of stock, no par value.

THE EAST-WEST REFINING CO., Los Angeles, Calif., care of James Westervelt, 522 Citizens National Bank Bldg., Los Angeles, representative, has been incorporated with a capital of \$100,000, to manufacture refined petroleum products. The incorporators are Fred S. Wilson and George B. Clark, Santa Monica, Calif.; and S. R. Harding, Los Angeles.

THE OSTRO PRODUCTS CORP., Jersey City, N. J., care of the United States Corporation Co., 15 Exchange Place, Jersey City, representative, has been incorporated under state laws with capital of 500 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are William E. Lake and James B. L. Orme.

THE EMPIRE DRAWN STEEL CORP., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of \$3,750,000, to manufacture steel products.

THE SWIHALL MFG. CO., 410 Rush St., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture rubber specialties. The incorporators are A. E. Anderson and Oscar W. Anderson.

THE WIRE FIBROUS PRODUCTS CO., Jersey City, N. J., care of the Corporation Trust Co., 15 Exchange Place, representative, has been incorporated with a capital of \$1,000,000, to manufacture fiber products.

THE LIBERTY PAINT PRODUCTS CO., care of the Colonial Charter Co., Ford Bldg., Wilmington, Del., representative, has been incorporated with a capital of \$100,000, under Delaware laws, to manufacture paint, varnish and kindred products.

THE Z. G. V. CHEMICAL PRODUCTS CO., Kearny, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are Robert E. Van Order, John E. Zellers and Lovett A. Grant, Jacobus Ave., Kearny. The last noted represents the company.

THE OSWEGATCHIE PAPER CO., Gouverneur, N. Y., has been incorporated with a capital of \$200,000, to manufacture paper products. The incorporators are S. B. and A. F. Wardwell and E. B. Sterling. The company is represented by Cobb, Cosgrove & Kimball, Watertown, N. Y.

THE LIMESTONE BRICK CO., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture sand-lime brick and kindred products. Robert J. Cram is president; and Drew B. Hall, 20 Georganna St., Braintree, Mass., treasurer. The last noted represents the company.

THE SENECA PETROLEUM CORP., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., representative, has been incorporated under state laws with a capital of \$1,000,000, to manufacture petroleum products.

THE BURKE-HUMPHREYS PRODUCTS CO., New York, N. Y., care of F. A. McKenzie, 305 Broadway, New York, representative, has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are C. Humphreys and J. H. Burke.

THE AUTOCESSORIES CHEMICAL CO., Waterbury, Conn., has filed notice of organization to manufacture special chemical products for automotive service. W. B. Price and R. W. Belfit, both of Waterbury, head the company.

THE WAVERLY RENDERING & BYPRODUCTS CO., Newark, N. J., care of the New Jersey Registration & Trust Co., 525 Main St., East Orange, N. J., representative, has been incorporated with a capital of \$125,000, to manufacture greases, lubricating products, etc.

THE LITTLEFIELD-SEGAL LEATHER CO., Peabody, Mass., has been incorporated with a capital of \$20,000, to manufacture leather products. Arthur S. Littlefield is president; and Chapin Segal, Abington, Mass., treasurer. The last noted represents the company.

THE MINTER CITY OIL MILL, INC., Min-

ter City, Miss., has been incorporated with a capital of \$30,000, to manufacture cottonseed oil products. The incorporators are M. F. Sturdivant and T. C. Buford, both of Minter City.

THE FUSITITE CORP., Watertown, N. Y., has been incorporated with a capital of \$100,000, to manufacture cement products. The company is a subsidiary of the Northern New York Utilities Co., Watertown. The incorporators are H. and N. A. Young, and F. A. Rogers, Watertown.

THE DUNBAR CANE PRODUCTS CORP., New York, N. Y., care of the United States Corporation Co., 65 Cedar St., New York, representative, has been incorporated under Delaware laws with capital of \$11,000,000, to manufacture sugar products.

THE BACON HILL BRICK CO., Atlantic City, N. J., has been incorporated with a capital of \$100,000, to manufacture brick, tile and other burned clay products. The incorporators are S. A. Burris and John C. Slape, 446 Guarantee Trust Bldg., Atlantic City. The last noted represents the company.

THE WILLIAMS LIME MFG. CO., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws, with capital of \$100,000, to manufacture lime and kindred products.

THE CO-OPERATIVE CUT GLASS WORKS, 446 Ash St., New Bedford, Mass., have filed notice of organization to manufacture glass products. G. G. Enos, 46 Holden St., New Bedford, heads the company.

THE FOURLOCK TILE CORP., Ridley Park, Pa., has been incorporated with a capital of \$20,000, to manufacture ceramic tile products. The incorporators are David Hennis, James G. Cooke and William R. Calligan, 15 East Felton St., Ridley Park. The last noted represents the company.

THE ALLEN COUNTY OIL CO., Scottsville, Ky., has been organized under state laws to manufacture petroleum products. The incorporators are Guy S. Amos and E. J. Lee Rust, Birmingham, Ala.; and C. W. Hill, and B. A. Hale, both of Scottsville.

Coming Meetings and Events

AMERICAN GAS ASSOCIATION will hold its annual convention and exhibition at Atlantic City, Oct. 23 to 28.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a 3-day national convention in New York, beginning Oct. 18. The general topic of the convention is "Economics of Industry."

TANNERS' COUNCIL will hold its annual meeting Oct. 19 and 20 at the Congress Hotel, Chicago.

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, 52 East 41st St., New York City: Oct. 13—Société de Chimie Industrielle, regular meeting. Oct. 20—Society of Chemical Industry, Grasselli Medal. Nov. 10—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting. Nov. 17—American Electrochemical Society, regular meeting. Dec. 1—Society of Chemical Industry, regular meeting. Dec. 8—American Chemical Society, regular meeting. Jan. 5—American Chemical Society, regular meeting. Jan. 12—Society of Chemical Industry, Perkin Medal. Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, joint meeting. March 10—American Chemical Society, joint meeting. March 23—Society of Chemical Industry, regular meeting. April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting. May 4—American Chemical Society, regular meeting. May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting. May 18—Society of Chemical Industry, regular meeting. June 8—American Chemical Society, regular meeting.